SCIENCE ABSTRACTS.

Section A.—PHYSICS.

AUGUST 1924.

GENERAL PHYSICS.

1977. *Correction of the Density of Liquids for the Buoyancy of Air.* **G. Barr.** (Chem. Soc., J. 125. pp. 1040–1045, May, 1924.)—A discussion of certain possible sources of error in density determinations of high accuracy by the pyknometer method. M. A. G.

1978. *Measurement of Surface Tension with Very Small Volumes of Liquid; the Surface Tension of Octanes and Xylenes at Several Temperatures.* **T. W. Richards, C. L. Speyers** and **E. K. Carver.** (Am. Chem. Soc., J. 46. pp. 1196–1207, May, 1924.)—The method consists in the measurement of differences of capillary rise in two narrow tubes of different diameters, the tubes being in communication at their lower ends. There is a discussion of the correction to be applied owing to the capillarity of the wider tube, for it is experimentally disadvantageous to have this tube of too great radius. The apparatus was standardised by means of pure water. With it the surface tension of water, three isomeric octanes, *o*-, *m*- and *p*-xylene, and ethyl benzene were determined, each at three temperatures. Equations are given for the calculation of the surface tension at any intervening temperature. The total surface energies are recorded; they change but slightly with changing temperature. The results are essentially in accord with the theory of atomic compressibility. A. A. D.

1979. *The Non-Metallic Elements. Connections between their Dielectric and Other Physical Properties.* **G. L. Addenbrooke.** (Phil. Mag. 47. pp. 945–965, May, 1924.)—Boltzmann, in 1873, described a method of obtaining dielectric constants by observation of the attraction of a small sphere of a dielectric hung near a large charged sphere, as compared with the attraction of a similar small metal sphere taken as a standard. This is now discussed at length, and Thornton's work is also included. In the present paper the conclusions reached from a general consideration of physical properties are applied to the electrical properties of certain non-metallic elements. In the case of surface tension and capillarity, a static or gravitational pull is balanced against the steady electric attraction of the molecules for each other or for a standard. In the melting- and boiling-points, the disruptive or shaking action of the electric waves is balanced against the steady natural electric attraction between the molecules. In vaporisation the connection seems to be with the energy stored, which is also proportional to the attraction. Finally, heat and light waves so overlap in frequency that what is true for the one must almost certainly follow for the other.

The difference between the effects of long electric waves and short in dielectrics appears to lie chiefly in the fact that with long waves there is a single potential slope throughout the dielectric, while with light and heat waves there are nearly always a number of complete waves in its thickness. Consequently, some of the molecular condensers subjected to light and heat waves are receiving a charge at the same time that others are discharging. This causes important differences, but rather of detail than of principle, and chiefly in the initial application and dying down of the field. Thus the electric attraction and the phenomena of capacity in dielectrics can be brought into line with work which has been done optically or at light frequencies, and both are brought into close relation with the phenomena of heat, surface tension and capillarity. Further connections exist between the electrical properties of the elements and their atomic weight or number, position in periodic table, and chemical action. The paper is very descriptive, and should be consulted in its entirety. H. H. Ho.

1980. *Vibrating Filament Stroboscope.* **A. Bertrand.** (Rev. Gén. d'Él. 15. pp. 848–850, May 10, 1924.)—The requirements of a mechanical stroboscope demand the production of flashes of light whose frequency is kept fixed at a certain value N as long as is necessary, and also the ability to vary easily and continuously this frequency N. An instrument fulfilling these requirements has been invented and made by A. Guillet, the principal being that the vibrations of a filament of metal or other material are perpetuated electrically by the movement of a contact placed at the actual point of attachment of the filament and operated either by direct or induced current. Near the middle of the filament is fixed an aluminium plate, in which is cut a narrow slit. This slit is placed opposite and very near to another practically identical slit in the wall, which forms the small base of a frustrum of a hollow cone incorporated in one of the supports of the apparatus. A beam of light directed into the frustrum of the cone and concentrated on the slit allows a certain space to be illuminated. As the filament vibrates with a frequency N, the flashes succeed one another with a frequency 2N. The author describes the action of the instrument, and gives as an example a method of measuring the speed of rotation of a motor. It can also be used to study parts of machinery in motion. [See Abstract 1718 (1923).] T. C. H.

1981. *Plotting Instrument.* **A. H. Sellman.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 693–696, May, 1924.)—The device consists essentially of two parts: the track and the ordinate arm. The track, containing the abscissa scale, is also the guide for the head or runner of the ordinate arm, and is fixed to the drawing-board. The ordinate scale runs in a groove of the ordinate arm, which is supported at its free end by a small wheeled carrier. The head of the ordinate arm is fitted with a slide-rule glass whose cross-line is directly over the abscissa scale. The ordinate arm carries a movable pointer with a slide-rule glass, and in this glass is a small hole, through which the plotted point is registered with a pencil. T. C. H.

1982. *Adjustment of Observations.* **N. Campbell.** (Phil. Mag. 47. pp. 816–826, May, 1924.)—In view of the recent suggestion by Edgeworth of the use of medians, as alternative to least squares, for reducing observations involving two variables, the claims for greater simplicity of the method of zero sum are again discussed. The method is described with special reference to two variables, and it is urged that there is no reason to believe that the method of zero sum is necessarily significantly inferior in accuracy to that of least squares. Methods are discussed whereby it might be possible to decide the question experimentally, such of them as have been essayed not indicating any difference between the two methods appreciable to experiment. A. B. C. L.

1983. *Free Pendulum.* **F. Hope-Jones.** (Roy. Soc. Arts, J. 72. pp. 446–458; Disc., 458–460, May 23, 1924.)—The aim has been to relieve the clock, or its pendulum, of interference, (1) by removing the contact applications for self-winding, and by using a cranked lever to drive the clock, lifting and resetting it by the armature of an electro-magnet as was accomplished in the " synchronome " remontoire; (2) by dispensing with the " escapement " and imparting the impulse to the pendulum when it is passing through its zero position. This last is done by the " synchronome " switch, a combination of a pendulum and a switch, the pendulum telling the switch when to work (usually every half-minute), and the switch imparting an impulse to the pendulum when it falls. [The switch is described.] It follows that the pendulum has only to count out the half-minutes (by pulling round an idle wheel) and to release the catch supporting the gravity arm. It would be " free " if these two duties were done for it, and this is accomplished by employing a " slave " clock, with the result that one pendulum measures time and does no work, whilst the slave does all the work and has its precise timing done for it. The slave is given a small losing rate of about six seconds a day, and as a result the phase difference of the two pendulums decreases until engagement takes place, with a consequent advancement of the slave's phase corresponding to the quickening action of the spring, and a cycle of such operations continues indefinitely. As long as the losing rate of the slave, relative to the master, does not increase to more than twelve seconds per day nor decrease to zero, the control by the master clock is complete. The whole is worked in a vacuum, so as to reduce the pressure. The synchronizer and the method of using it in combination with the synchronome system to produce the free pendulum is the invention of W. H. Shortt. This free pendulum clock has been run at the Edinburgh Observatory [see next Abstract], where it has succeeded in measuring time for considerable periods to within 100th of a second per day, or 1 in 8 millions. In the *Discussion*, the points raised were: by the **Astronomer Royal,** whether small seismic vibrations might not affect the accuracy attainable; by **C. O. Bartrum,** whether there were not at times some external effect which made the three Edinburgh clocks alter their rate together; by **C. E. Prince,** whether it would not be better to give thirty small impulses per half-minute rather than one single impulse; by **R. J. Low,** whether the changing rate of the clock might not be correlated with magnetic charts, or with the gravitational effect of the position of the moon, the sun, or the tide, and if it were not inadvisable to have a magnetic field near a swinging pendulum. A. S. D. M.

1984. *Studies in Clocks and Time-Keeping. Part III. Comparative Rates of Certain Clocks.* **R. A. Sampson.** (Roy. Soc. Edinburgh, Proc. 44. 1. pp. 56–76, 1923–1924.)—The same order of discrepancies, as are seen in night-to-night determinations at a single observatory, are shown in those made at various observatories, and may have a range as large as 0″·3. The clock problem is to devise a manageable *process* which shall be uniform in time, and to ascertain precisely what is happening in any particular interval of time; the multiplication of clocks confers no benefit unless these are as good as the best already in use. The author gives a study of the going of four clocks when all known causes of variation have been removed; he deprecates any obliteration of discrepancies in the going of clocks by smoothing, as these discrepancies form the material and evidence for study; he adopts one clock as *director*, and the errors, as indicated by stellar observation for it, are charted as observed, without smoothing, and against these are set the relative going of the director and each of the other clocks. Tables of the results are given. [See Abstract 1256 (1922).] A. S. D. M.

1985. *A Vibration Recorder.* **C. G. Beall** and **C. I. Hall.** (Gen. El. Rev. 27. pp. 297–303, May, 1924.)—This article consists in a description of an optical method of recording muscular tremors, and is mainly of medical interest. W. H. S.

1986. *Lewbeck Projection Micrometer.* (Engineering, 117. p. 716, May 30, 1924.)—This instrument operates by forming a highly magnified image of the wire or fibre on a translucent screen provided with an adjustable scale to measure the width of the image formed. The essential parts—*i.e.* illuminating lamp, projection microscope, reflecting mirror and translucent screen—are all mounted in fixed positions on a rigid base plate. It is only necessary in making a measurement to bring the zero of the scale into coincidence with one side of the magnified image on the screen; the position of the other side of the image on the scale then gives the diameter. The scale is divided into tenths of an inch, and as the magnification is 1000 diameters, each division corresponds to 0·0001 in. A Pointolite lamp is used, the light from which passes through an aperture in the lantern and travels by a lens and reflecting prism to a condenser of the microscope. Between the condenser and the microscope objective is the wire, secured in a holder. The operation of inserting the wire and measuring its diameter can be carried out by the operator without changing his position. T. C. H.

1987. *Measurement of Ocean Depths by Acoustical Methods.* **H. C. Hayes.** (Frank. Inst., J. 197. pp. 323–354, March, 1924.)—The various devices previously developed are briefly reviewed and their principal limitations discussed. A simple explanation is given, based on the mutual cancellation of direct and surface-reflected rays, of the fact that the only sounds heard in a submarine sound-receiver located near the surface are the components that have been reflected from the sea-bottom. Two methods, referred to respectively as the "Angle of Reflection Method" and the "Standing Wave Method," are described, and serve for the measurement of depths less than about 100 fathoms. In the first method the source of sound (*e.g.* the ship's propeller) is at one end of the ship and two receivers are placed at the other end, at a known distance apart. By the employment of the human binaural sense, a position of equilibrium between the two receivers is determined, from which the length of path traversed by the sound waves, and hence the ocean depth, can be calculated. To compensate for shelving sea-bottoms, the transmitting and receiving devices are duplicated at the reverse ends of the ship, and a correction applied according to a formula given. In a refinement of this method a number of receivers are electrically connected to magnify the transmitted sound and to weaken local disturbing sounds. In the second method the sound transmitter is actuated by an alternating current of known variable frequency, which also actuates inductively one telephone of a two-telephone head set. The other telephone is connected with the output from the sound receiver. Having obtained binaural balance by adjustment of the frequency, the latter is gradually raised or lowered until binaural balance is again obtained, the depth being calculated from the frequency variation required to produce this effect. A third method, called the "Echo Method," serves for measuring any depth greater than about 40 fathoms. A continuous series of short sound signals separated by equal time intervals is sent out, a special device being employed by which the time interval can be varied and accurately determined, the general arrangement being similar to that employed in the standing wave method. Detailed comparisons of results obtained with those obtained by methods other than acoustical methods are given, and good agreement is shown. A. B. C. L.

1988. *Measurement of the Size of the Drops in an "Atomised" Liquid.* **F. Häusser** and **G. M. Strobl.** (Zeits. techn. Physik, 5. 4. pp. 154–157, 1924.)—This is a quick technical method for the determination of the size of drops formed by an "atomising" device. It also gives information relative to the number of drops of a particular radius in any stream so that frequency curves may be plotted. A microscope cover slip coated with a suitable oil is passed rapidly through the stream under investigation. Examined subsequently under the microscope, the droplets are seen floating in the oil, and may be counted and measured in the usual way. A few curves are given relative to the formation of water drops in an air blast for different sizes of nozzle. A. A. D.

1989. *A Method of Drawing Metallic Filaments; their Properties and Uses.* **G. F. Taylor.** (Phys. Rev. 23. pp. 655–660, May, 1924.)—If a glass tube filled with a molten metal is placed in a tubular furnace or in a transverse hole through a heated copper rod and drawn out at the proper rate, metal filaments of almost any degree of fineness may be obtained down to a diameter of 10^{-5} cm., or even less. The glass or quartz used must soften at a temperature between the melting- and the boiling-point of the particular metal. Filaments of Pb, Sb, Bi, Au, Ag, Cu, Fe, Sn, Tl, Cd, Co, Ga, and In have been made by this method. The glass envelope may serve as insulation or may be removed, if desired, with HF. The filaments are very pliable, and have greater *tensile strength* than wires of ordinary size. The *temperature coefficients of resistance* were not found to differ markedly from those of the metals in bulk, and to be more constant. Metallic filaments made in this way have been used for resistance thermometers, thermocouples, galvanometer suspensions, and hair lines for the eye-pieces of telescopes. Their use in micropiles, bolometers and the moving coil of both direct and alternating current galvanometers is suggested. Conducting quartz threads were made by drawing down a tube with a silver core. AUTHOR.

1990. *Capillary Mercury Lamp.* **J. H. Vincent and G. D. Biggs.** (Journ. Sci. Instruments, 1. pp. 242–246, May, 1924.)—Clean, dry mercury is poured into an open U-tube, one portion of which is a quartz capillary. When a direct e.m.f. upwards of 100 volts is applied by iron electrodes dipping into the mercury in each limb and the central part of the capillary is heated, an arc can be started and maintained in the capillary. The lamp takes very little current, and apparently lasts indefinitely. Details of construction and behaviour are given. G. A. S.

1991. *An All-Metal High-Vacuum Pump System.* **I. Backhurst and G. W. C. Kaye.** (Phil. Mag. 47. pp. 918–929, May, 1924.)—The system described is a two-stage pump consisting of a mercury vapour jet pump in series with a mercury vapour condensation pump. The first stage pump is made of steel, all joints being welded. Mercury vapour from a boiler is discharged through a stream-lined nozzle situated in a throat between the space to be exhausted and a water-jacketed condensing chamber. The pressure in this chamber is kept low (2 mm.) by an ordinary piston pump. The condensed mercury returns to the boiler through a tube. This arrangement will produce a vacuum of less than 0·001 mm., and its "speed" (as defined by Gaede) is about 300 c.c./sec. The second stage pump is substantially as designed by Langmuir, and begins to operate when the first has reduced the vacuum below 0·03 mm. The speed of the system rapidly rises to about 6000 c.c./sec., and by careful adjustment of temperature this speed can be increased to 10,000 c.c./sec. Among the advantages claimed for the system are high speed; absence of moving parts and vibration; vapours are as easily pumped as permanent gases, so no drying or other reagents are required; low running costs; robust construction. W. G. B.

1992. *A Metal Annular-Jet Vacuum Pump.* **I. Backhurst and G. W. C. Kaye.** (Phil. Mag. 47. pp. 1016–1020, May, 1924.)—On account of the difficulties encountered in the welding of the joints of the pump, described in a previous paper [see preceding Abstract], a new method of construction is described. The outer casing is made from a piece of weldless steel tube, and caps are screwed on the ends, the joints being made airtight by thorough copper and nickel plating. The use of an annular jet greatly increases its speed when functioning as a jet pump, though as a condensation pump its speed is restricted by the narrow width of the jet. The pump will readily produce a vacuum of 0·00001 mm. of mercury when working against a back pressure of 1 mm. at a speed varying between 1000 and 7000 c.c./sec., depending on the back pressure. W. G. B.

1993. *Entrainment of Air by a Jet of Gas issuing from a Small Orifice in a Thin Plate.* **J. S. G. Thomas.** (Phil. Mag. 47. pp. 1048–1056, May, 1924.)—In continuation of the work previously described [see Abstract 405 (1924)], the effect of restricting the supply of air is studied. The most marked result is that the "aeration" tends to become practically independent of the jet pressure, as the supply is more restricted, and at higher pressures the "aeration" decreases as the pressure increases. W. G. B.

1994. *Elastic Limit and Strength of Crystals.* **A. F. Joffé, M. V. Kirpitcheva** and **M. Levitzky.** (Nature, 113. pp. 424–425, March 22, 1924.)—A preliminary communication to the Petrograd Academy of Sciences, not yet printed, is here summarized by the authors. Joffé has already [Abstract 1615 (1922)] described a method for observing the change of structure accompanying the residual strain of crystals and their elastic constants based on graphs obtained from X-ray observations. The elastic limit has now been measured at different temperatures and in different directions, and the results are given in a diagram. The elastic limit of rock-salt becomes zero at the melting-point 810° C. The breaking tensile stress represented on one of the curves was examined, and no appreciable change of this occurs between − 190° and + 650° C. The temperature dividing the brittle and the plastic state of the crystal depends upon the kind of strain and the orientation of rock-salt. [See also Zeits. f. Physik, 22. 5. pp. 286–302, 1924.] J. J. S.

1995. *Valve Method of Detecting Minute Slipping in Metals.* **C. Handford.** (Phil. Mag. 47. pp. 896–907, May, 1924.)—A small polished piece of metal is clamped against the polished face of the test-piece under observation, but is electrically separated from it by a very thin sheet of mica. This forms the condenser of an oscillatory circuit connected to a thermionic valve, the inductance of the circuit being so chosen that the oscillation frequency is of the order of ten million. A similar circuit, containing a variable condenser in place of the test-piece, etc., is very loosely coupled to the former, and the condenser is adjusted until a heterodyne note is heard in the telephones in the second circuit (the rectified current from the valve of the second circuit is passed through a two-valve amplifier to make the note sufficiently loud to hear easily above the laboratory noises). The test-piece is then loaded, and as soon as any slip takes place, the distance increases between the test-piece and the piece of metal clamped to it. This alters the frequency of the first circuit, and hence the note in the telephones. Slip indicated in this way is shown to occur at lower loads—sometimes much lower loads—than is shown by the usual visual method. Full details of the method and calculations as to its sensitivity are given in the paper. J. L. H.

1996. *Electrical Registration of Tide Levels.* **J. de G. Hunter.** (Journ. Sci. Instruments, 1. pp. 246–249, May, 1924.)—Of more use to mariners than the bare statement of height and time of high and low waters is information as to the times at which the water reaches given heights above a datum level. A device is described which can be fitted to a tide-predicting machine to record electrically the times at which such prescribed heights are reached, the record also showing whether the water is rising or falling. The device may be found useful on other machines where vertical motion is recorded against time or other abscissa. G. A. S.

1997. *Mean Distance Between Neighbouring Molecules in a Fluid.* **C. V. Raman.** (Phil. Mag. 47. pp. 671–679, April, 1924.)—In connection with the theory of scattering of X-rays in fluids by Ramanathan and himself [see Abstract 893 (1923)], the author found a knowledge of the mean distances between neighbouring molecules in a fluid requisite to the evaluation of their results. He could not find any satisfactory treatment of the subject. In this paper he points out defects in Gans's treatment [see Abstract 736 (1922)]. The author uses two distinct methods, both due to Boltzmann. In one of these his thermodynamic principle of Entropy-Probability is applied, and the chance that the nearest neighbour of a given molecule is situated at a specified distance from it is expressed in terms of the work done in creating a spherical cavity round the molecule in question. In the other one Boltzmann's Distribution Law is used. The expressions obtained from the two methods are formally analogous. Where λ is the mean distance, n is the number of molecules in unit volume, and k is a number varying from 0·554 in the case of an ideal gas up to 1·12 for the closest packing, it is found that $\lambda = kn^{-1/3}$. The value of k for the liquids dealt with varied from 0·8 to 1·0. For dense fluids, λ is of the same order as the molecular diameter, but may be from 10 to 20 % greater. Fairly accurate values of λ are obtainable by a very simple mathematical treatment. G. W. DE T.

1998. *Interpretation of Surface Energy Data.* **G. M. Bennett.** (Chem. Soc., J. 125. pp. 958–959, April, 1924.)—Reference is made to the widely accepted view as to the lack of general significance of the figure 2·12 obtained by Ramsay and Shields as the mean value of the Eötvös coefficient for six liquids of molecular weights between 60 and 154, and it is pointed out that the explanation sought by Schenck and Kintzinger in discussion of higher values obtained by them for *n*-hexacosane, *n*-myricyl alcohol and *n*-hexacontane as exceptions to the Eötvös-Ramsay-Shields generalisation is unnecessary. A. B. C. L.

1999. *A New Principle in the Analysis of Periodicities.* **C. F. Marvin.** (Monthly Weather Rev. 52. pp. 85–89, Feb., 1924.)—In the examination of data for periodicities the following principle must be noted: "The several terms of a limited and finite Fourier series do not necessarily represent single or unique harmonic components of the data analysed, but each term may, theoretically at least, represent two or even several wholly independent components with widely different periods." The principle is illustrated by the consideration of some examples. It is shown that all periodicities in the original data, of shorter wave-length than the shortest to be expected, will tend to remain disguised as periods of long wave-lengths. Rules are given by which these spurious periodicities may be eliminated, and it is pointed out that sequences of wholly fortuitous numbers will always exhibit periodic features, and these, as well as all real commensurate periods, can be evaluated by the Fourier analysis or other devices. Only those features which consistently survive and emerge from every analysis can be regarded as real periodic features in any body of data. [See also Abstract 1371 (1924).] A. A. D.

2000. *Stability under Shearing Forces of a Flat Elastic Strip.* **R. V. Southwell and Sylvia W. Skan.** (Roy. Soc., Proc. 105. pp. 582–607, May, 1924.)—The investigation is entirely mathematical, and is based on the usual approximate theory of thin plates. It relates to a uniform elastic strip upon which a uniform shear is imposed by tangential tractions applied along its edges. The results have some bearing on the stability of webs of plate girders, and it is shown that it is necessary to contemplate the occurrence of elastic instability under stresses which the material would otherwise sustain without injury. The wave-length of the distortion which is likely to occur depends on the breadth of the strip and not on its thickness. The design of light-metal constructional members of aircraft is conditioned mainly by considerations of stability, and it is important that their resistance to buckling should persist after the elastic limit of the material has been exceeded. Calculations are made under two assumptions as regards the constraints exerted on the edges of the strip: (1) "Simple Support," in which no flexural couples are imposed, and (2) "Clamping." For each of these conditions the frequency of transverse vibration is determined in terms of the shear, and the non-dimensional results are presented graphically. It is deduced that a steel strip, having a ratio of breadth to thickness of 100 : 1, would be liable to buckle under shear stresses of 6·63 and 11·13 tons/sq. in. respectively for the two conditions considered. The corresponding wave-lengths of transverse distortion are 2·67 and 1·6 times the breadth of the strip. Methods are indicated whereby the fundamental solutions can be applied to the case in which the strip is subjected to uniform tension and compression in addition to the shear. J. V. H.

2001. *Experiments on the Duration of Impacts.* **J. E. P. Wagstaff.** (Roy. Soc., Proc. 105. pp. 544–570, May, 1924.)—Experiments in which the time of impact for steel bars with rounded ends is measured, carried out to test the theories of Hertz and St. Venant, are described. The duration of contact is measured by determining the loss of charge of the plates of a condenser, the terminals of which are connected to the two impinging bars. The bars are supported by a four-wire suspension, capable of fine adjustment, as it is essential that they impinge in perfect alignment. The velocity of approach is varied by altering the distance through which one is withdrawn before release. From the results it is seen that a relation of the form $t = Av^n$ holds, connecting the time of contact, t, and the velocity of approach, v. The index n varies from $-0{\cdot}24$ for short rods to zero for long ones, showing that in the latter case the time is independent of the velocity, as demanded by the St. Venant theory. Further experiments, in which lengths and diameters of the bars are varied, led to a relation $-1/n = A + Kl/r$, in which the first term can be interpreted as representing the "static" Hertz theory, and the second the "dynamic" St. Venant theory. Finally, all the results can be expressed by the formula, $t = (Mr^2/a + Bl)v^n v^{-n-1}$, V being the velocity of sound in the material, $\sqrt{E/\rho}$, and a the radius of curvature of the ends. The M term is in the nature of an "end correction." It is suggested by the fact that for long bars the formula becomes $1{\cdot}3\ l/V$ that there is evidence of a wave-speed greater than V, due to its intense and adiabatic nature. W. G. B.

2002. *The Amplitude of Forced Torsional Vibrations in a Shaft.* **C. Platrier.** (Comptes Rendus, 178. pp. 1362–1365, April 14, 1924.)—Obtains an integral formula for the amplitude of torsional vibration in a shaft of varying diameter subjected to periodic torque distributed along its length. W. G. B.

2003. *Torsional Resonance of Shafts.* **C. Platrier.** (Comptes Rendus, 178. pp. 1143–1145, March 31, 1924.)—Introduces a symbolic notation to facilitate the calculation of the frequencies of resonance of a shaft consisting of portions of various diameters, subjected to oscillating couples. W. G. B.

2004. *Rotation of a Sphere in a Rarefied Gas from the Point of View of the Kinetic Theory.* **G. Breit.** (Phys. Rev. 23. pp. 608–616, May, 1924.)—The analogous two-dimensional case is first treated. The method used is to replace the gas by a suitable model having a comparable mean free path, consisting of a number of concentric rough circles with molecules of negligible diameter traversing the intervening space and serving to transfer angular momentum from one circle to the next. The first order correction term in the expression for the mean free path is obtained, the moment on the model due to the rotation, and the corresponding coefficient of viscosity. The results are shown to apply to a two-dimensional gas, and are readily extended to the analogous three-dimensional case, giving the moment of force L in terms of the ordinary hydrodynamic expression L_0, the mean free path λ, and the radius r, namely, $L = (1-3\lambda/r)L_0$. The procedure used by Cunningham for the analogous translational case seems to be applicable here, even though its validity for the translational case is questionable. AUTHOR.

2005. *Dynamical Illustrations of Radiation Pressure and Adiabatic Invariance.* **T. H. Havelock.** (Phil. Mag. 47. pp. 754–771, April, 1924.)—The associated ideas of vibration pressure and of certain adiabatic invariants suggest a number of problems concerning simple dynamical systems with a moving constraint. The type of problem dealt with in this paper may be represented by the transverse vibrations of a string stretched at constant tension, one end being fixed and the other passing through a small hole in a plate which moves along the string with uniform velocity v.

(1) In the case of a single particle attached to a light string, the equation of motion is solved and an asymptotic expansion found for small values of v; this is applied to demonstrate the adiabatic invariance of E/n, where E is the energy, and n is the frequency. Let C be the fixed point and CR the line of motion of the small hole R, and suppose the particle to move between smooth guides through C at right angles to CR; for small motions this is analytically similar to the Rayleigh pendulum, a simple pendulum swinging under gravity with the length altering at a uniform rate. (2) In the case of a uniform string, solutions are found which give a stationary node and a travelling node. An interesting application of this is the generalising of the result of Larmor's well-known device for illustrating radiation pressure. By considering incident and reflected simple harmonic waves at a moving reflector, he obtained the pressure, p, of radiation in the form $p = (c^2 - v^2)e_R/(c^2 + v^2)$, where c is the wave velocity, v the velocity of the reflector, and e_R the density of energy in front of the reflector. Note that p and e_R have in his analysis their average values for simple harmonic waves. It is here shown that Larmor's equation holds good without any restriction to simple harmonic waves and average values of the quantities involved. (3) Similar solutions are indicated for plane electromagnetic waves between fixed and moving planes which are perfect reflectors. (4) As a simple case of a dispersive medium, the author considers the transverse vibrations of a uniform string under constant tension, each particle of which is attracted

to its equilibrium position by a force proportional to its displacement, and finds that Larmor's formula in its generalised form holds good for a dispersive medium, provided the dispersive property here attributed to the string can be regarded as adequately representing a dispersive medium. The author verifies the conclusion in the case of simple harmonic waves and average values. G. W. DE T.

2006. *The Determination of the Crystal-Axes in "Single-Crystal" Aluminium Bars by Means of X-Rays.* **A. Müller.** (Roy. Soc., Proc. 105. pp. 500–506, May, 1924.)—The measurements were made in connection with the determination, by Taylor and Elam, of the position of the slip planes during extension, by geometrical observations. The method of defining the position of the lattice relative to a reference plane in the bar is described, together with the method of mounting to obtain the X-ray photographs and the manner of interpreting them. The spots on the photographic plate were as a rule very small at first, but, as the extension went on, the range of reflection frequently increased, and it was noticed that the size of the reflected spots became larger. Assuming that the material breaks up into small crystals, a rough estimate can be made, from the spot dimensions, of the angle between the surfaces of pairs of these small crystals. As these small crystal aggregates remain very nearly in the same average position after considerable extension, the test-piece can be still considered a single crystal. A series of Laue photographs showed the existence of relatively large crystals very near the edges where the sample was broken. This shows that the edge, in spite of the violent distortion, is not in a completely amorphous state. H. N. A.

2007. *The Space Lattice of Triphenylmethane.* **K. Becker.** (Zeits. f. Physik, 24. 1. pp. 65–68, 1924.) Note by **H. Mark** and **K. Weissenberg.** (*Ibid.* p. 68, 1924.)—This refers to a paper by Becker and Rose [Abstract 1589 (1923)], in which the dimensions of the elementary cell were given, and it was found to contain three molecules. Mark and Weissenberg obtained different dimensions, and according to these the elementary cell contains eight molecules. The author has repeated the measurements, using crystals supplied to him by Mark, and finds, first, that the crystals are of the same nature as those previously used by him; and second, that in the original measurements an error was made in measuring the distance of the photographic plate from the crystal; correcting for this the number of molecules per elementary cell becomes four, and the dimensions are of the same order as those of Mark and Weissenberg, except that their value for b is about twice as great as that now obtained. In their note Mark and Weissenberg explain that their value for b is confirmed by all the uneven numbered layer lines in the diagram taken about the b axis. H. N. A.

2008. *Magneton Numbers and Atomic Structure.* **J. Dorfmann.** (Zeits. f. Physik, 23. 5. pp. 286–293, 1924.)—The paper attempts to bring the empirically determined magneton numbers into relation with Bohr's theory of atomic structure; quantum numbers are supposed to be in all cases whole numbers; the space quantelation of the electron orbits is carried out in accordance with the original theory of Pauli. Atoms which, according to Bohr, have a closed configuration, a considerable degree of symmetry, are diamagnetic; the closed groups consist of 2, 4, 6, 8 similar n_k orbits; paramagnetism is observed when a group with an uneven number, 1, 3, 5, 7, of similar n_k orbits can be assumed. In the iron group paramagnetism is found when the 3_1, 3_2, 3_3 orbit groups change gradually from a configuration $4-3_1$, $4-3_2$, $0-3_3$ to $6-3_1$, $6-3_2$, $6-3_3$ orbits, and vanishes as soon as the groups are closed. An orbit group with one electron has a magnetic moment which depends simply on the k number of the orbit; if, however, the groups have 3, 5, 7 orbits the magnetic moment depends not only on the k values, but also on the relative orientation of the orbits. The author assumes that with $2p + 1$ orbits, in an n_k group, $2p$ of them form a symmetrical diamagnetic complex, and the extra orbit produces paramagnetism, and gives the atom a moment of k units. If there are several asymmetrical groups the magnetic moment may be simply the sum of the moments due to the separate groups, $M^2 = (M_1 + M_2 + \ldots M_i)^2$, or may be given by the equation $M^2 = (M_1^2 + M_2^2 + - M_i^2)$; it is assumed that the first equation holds when the principal quantum number is the same for all groups, and the second when the values of n are different. The atomic moment M_B expressed in Bohr magnetons cannot exceed the sum of the azimuthal quantum numbers of the asymmetrical groups $k_1 + k_2 + k_3 + \ldots k_i = Q_k$; in the iron family, for example, the n_k groups 3_1, 3_2, 3_3 and 4_1 may be asymmetrical; if they are all asymmetrical, and the moments simply add $M_B = Q_k = 1 + 2 + 3 + 1 = 7$; in Weiss magnetons this corresponds to $M_w = 38 \cdot 6$, the maximum observed value being 29–30·4. Orbit configurations have been worked out for the different ions of the iron group of elements which give nearly equal values for the observed and calculated values of the magnetic moment; the same has been done for the ions of the rare earths, though here the observational material is by no means complete.

H. N. A.

2009. *Geometrical Introduction to General Relativity Theories.* **G. Darmois.** (Ann. de Physique, 1. Ser. 10. pp. 5–88, Jan.–Feb., 1924.)—The paper is prefaced by some introductory definitions and explanations of the general nature of the Gauss-Riemann geometry of hyperspaces, after which the subject is developed in five sections. (1) The concept of an invariant is introduced, especially in the tensor form, which is the natural outcome of the discussion of multilinear forms in the relation to the coordinates of points or hyperplanes in the domain of points infinitely near to a given point. From this follows naturally the classical tensor theory. (2) The Einstein introduction of the quadratic form leads directly to various types of tensor essentially the results of a transformation of straight lines into polar planes with respect to a second order cone. Geodesics and parallel hypersurfaces are discussed, and the definition of parallel displacement leads rapidly to the definition of the Riemann-Christoffel tensor and then to Einstein's gravitation tensor. (3) Applications are made to ordinary surfaces, then to hyperspaces. Riemann coordinates are considered, and a second fundamental quadratic form which appears to fulfil an important rôle in existence theorems of Einstein's equations. (4) Here is developed especially the form taken by Einstein's equations in Gauss coordinates, formed by geodesic normals to a subspace. Hence are established the existence theorems of the equations of the exterior problem in an important case. (5) Gauss coordinates are here applied to quadratic forms possessing spherical symmetry. Hence are obtained very simple solutions of problems derived by Schwarzschild from the ordinary equations, and by Weyl, Eddington and Chazy for the complete equations of the external problem. The internal problem responds to similar treatment. G. W. de T.

2010. *Physical Basis of Relativity.* **N. Spampinato.** (Accad. Lincei, Atti, 33. i. pp. 132–136, Feb. 17, 1924.)—The Lorentz transformations used in relativity are methematical concepts merely, independent of effective consideration of the singular cases of translatory motion of the two systems *k* and *k'*. This is not much in favour of the solidity of the physical bases of the Einsteinian theory. A. D.

2011. *The de Sitter World.* **M. v. Laue and N. Sen.** (Ann. d. Physik, 74. 3. pp. 252–254, May, 1924.)—The spherical symmetrical solutions of the gravitational equations for given tensor components have been already given [see Abstract 1405 (1924)], and from them and the general conditions of instability the gravitational field of a spherical shell (with a surface coating of matter) has been derived. The λ-term, however, was completely ignored for this purpose, and the present mathematical paper discusses the de Sitter world which obtains by the re-introduction of this term. This world is now established as the limiting case of the gravitational field within a spherical shell, and if only positive values are required it is found immaterial what value is given to the mass density on the spherical surface. H. H. Ho.

2012. *Diverse Significations of "Velocity" in Relativity Theory.* **Lémeray.** (Comptes Rendus, 178. pp. 1145–1148, March 31, 1924.)—In Newtonian mechanics, suppose several planets of equal energy densities to pass successively through a point in the sun's gravitation field without sensibly affecting it, they will pass through it with equal velocities, independent of the direction; so that if a vector be drawn from that point, always equal to the velocity in its direction, the locus of its other end will be a sphere. Moreover, the tangential and radial velocities are everywhere uniquely defined. In the Einstein relativity theory either of these velocity components, and, of course, the total velocity, may be uniquely defined as having the value determinable by a local effective observer, that is to say, by an observer who, at the moment of observation, is immobile but subject to the gravitation field, so that he himself and his measuring instruments—such as rules, graduated circles, clocks, etc.—are subject to the Lorentz transformation. To secure the temporary immobility, the author places his observer at the apex of a radial trajectory, which also simplifies Schwarzschild's equation for ds^2, which is then integrated by the usual variation $\delta\int ds = 0$, and derives the radial and transverse velocities (so called) in the usual manner. The author calls these the *theoretical* values. The spherical locus of Newtonian mechanics, referred to above, is then replaced by an oblate spheroid.

But the *observational* values are also directly calculated, and they are found to be equal, giving a spherical locus as in Newtonian mechanics. He deduces, further, the important result that, while the *theoretical* values vary from point to point in the sun's gravitation field, the *observational* values give a rigorously invariant value everywhere in the sun's field. The author points out that it is therefore incorrect to speak of the bending of a light ray in the sun's field. Even if this explanation were employed in relation to the *theoretical* values it would be incorrect, for the velocity would then vary with the radial direction as well as the radial length. G. W. DE T.

2013. *A Stationary Cosmology in the Sense of Einstein's Gravitation Theory.* **K. Lanczos.** (Zeit. f. Physik, 21. 2. pp. 73–110, 1924).—In the general relativity theory a universe is stationary when its measurement-coefficients are independent of the time, provided we have a coordinate system in which the mean measurements are constant. The proviso is essential, since time is proper time and not in itself an invariant. Points where there is no matter may be explored by finding whether a test body of vanishing mass would be in equilibrium there. The necessary and sufficient condition for this is that the time lines should be geodesics. De Sitter's statical solution of the cosmological equations does not give a stationary universe, nor does Schwarzschild's; there is no general stationary solution which is at the same time spherically symmetrical; and Einstein's cylindrical universe is, so far, the only stationary universe. But this implies that the average density of distribution of matter, and therefore the total mass of the universe, shall have a determinate value, which appears not to be an admissible assumption. The author works out a solution which does not involve any relation between the mass and the cosmological constants. It is a type solution for the greatest possible degree of symmetry; the coefficients of the tensors depend upon x only, and $g_{23} = 0, g_{24} = 0$; but it opens up a wide outlook. In a stationary universe the mass-density must everywhere be positive, and it can never be less than that of an Einsteinian cylindrical universe. Numerous consequences, including re-entrant light-paths and possible astronomical phenomena, are traced out. [See Abstract 1052 (1923).] A. D.

METEOROLOGY AND GEOPHYSICS.

2014. *Polar-Front Theory.* **A. Defant.** (Meteorolog. Zeits. 41. pp. 1–9, Jan., 1924.)—The theory of the motion of a cold mass of air over a fixed plane surface through warm air is worked out. The form of the surface of discontinuity for a stationary mass is determined. A construction is given for determining the form of an advancing or retreating mass, and diagrams illustrating the periodical variation in the polar basin with the corresponding extension of the polar front southwards are added. [See Abstract 1708 (1924).] W. A. R.

2015. *The Selective Absorption of the Atmosphere Observed at Pic du Midi.* **J. Baillaud.** (Comptes Rendus, 178. pp. 1834–1836, May 26, 1924.)—Determinations of the atmospheric absorption have been carried out at the Pic du Midi Observatory in 1920 and 1921. Two different instruments were used, but simultaneous photographs of the two luminous sources were obtained with each. The results obtained may be divided into two groups: (1) Results in agreement with those obtained by most other investigators; (2) results in agreement with those obtained by Fabry and Buisson. The latter show an absorption band in the ultraviolet around $\lambda = 380\ m\mu$; it is suggested that this absorption is caused by the water-vapour present, but only occurs when the latter is in the unstable state preceding condensation. A. W. L.

2016. *Atmospheric Pollution.* (Meteorolog. Office, Air Ministry, M.O. 260. [59 pp.], 1924.) W. R. C.

2017. *Atmospheric Polarisation.* **N. N. Kalitin.** (Meteorolog. Zeits. 41. pp. 9–15, Jan., 1924.)—Results of observations made at Pawlowsk Observatory on the dependence of polarisation on the transparency of the atmosphere are given in this paper. The correlation between the intensity of solar radiation and the amount of polarisation is high and positive. Cloudiness has a disturbing effect, and it is clear that for comparisons observations should be made with a clear sky, or at least only light, high clouds should be present. The effect of a layer of snow on the ground is to reduce the amount of polarisation by the interference of the light reflected. There is also a clear dependence of amount of polarisation on the weather type. For the district concerned polarisation is a maximum for a north wind and a minimum for a south wind.
W. A. R.

2018. *Diurnal Variation of Atmospheric Pressure at Eskdalemuir and Castle O'er, Dumfriesshire.* **A. C. Mitchell.** (Roy. Meteorolog. Soc., J. 50. pp. 127–135, April, 1924.)—The hourly values of atmospheric pressure at Eskdalemuir Observatory, Dumfriesshire, for the ten years 1911–20 have recently been reduced, and the mean diurnal inequalities obtained for each month of the year and for each year, as well as the harmonic components of these as far as the fourth term of the series. The present paper contains a comparison of these results with corresponding figures given by Chree (*ibid.* 37. p. 325, 1911) derived from the records from a Richard barograph at Castle O'er for the seven years 1902–08. Both stations are situated in the valley of the Esk, and they are 9·6 km. apart. The two sets of results show very considerable discrepancies, and the cause of these is discussed. The possibility of different geographical position and local topography being responsible is ruled out, as is also the fact that the records are for different series of years, and the different results are attributed to imperfect temperature compensation in the Castle O'er barograph (which stood on a mantle-shelf above a fireplace in a sitting-room).

The publication of such a detailed comparison of the pressure records at contiguous stations is justified because of the importance of a high order of accuracy in the results used in building up a theory of the diurnal variation of atmospheric pressure, and in this connection the author does not think that the Castle O'er record can be accepted as representative of the area in which that station is situated.
M. A. G.

2019. *Comments on the Law of Pressure Ratios.* **F. J. W. Whipple.** (Monthly Weather Rev. 52. pp. 94–95, Feb., 1924.)—The law of pressure ratios may be expressed by the equation $p_3/p_2 = (a \cdot p_2/p_1) + b$ [see Abstract 774 (1924)]. From a study of the correlation between the average temperatures in the layers considered, the author concludes that the value of *a* cannot exceed 2·34; consequently the values obtained for Groesbeck and Leesburg (2·58 and 2·76) require verification. If these values are neglected, the application of the formula becomes more general, since the variation of *a* from place to place is much smaller.
A. W. L.

2020. *Method of Forecasting Cloud and Rain.* **L. Petitjean.** (Comptes Rendus, 178. pp. 1380–1381, April 14, 1924.)—Outlines briefly, without actual examples, a graphical method of determining the movement of zones of precipitation such as are associated with the discontinuities of Bjerknes, using as a basis synpotic charts giving the distribution of surface wind. M. A. G.

2021. *The Probability of Rain.* **L. Besson.** (Comptes Rendus, 178. pp. 1743–1745, May 19, 1924.)—Observations at Montsouris for a period of fifty years give 9580 rain days in this period; thus, if the occurrence of rain on the previous day is neglected, the probability of rain on any day is 0·525. The probabilities of rain, when it has rained for periods from one to thirty days previously, have been computed; this probability is 0·704 when the previous day has been rainy, and increases to 0·8 when it has rained on the preceding fifteen days. For longer rainy periods the probability appears to decrease, but this may be caused by the small number of such periods in the observations. Values of p, the general probability of a rain day, p_1, the probability of a rain day when the previous day has been rainy, and of R, the coefficient of persistence, $(R = (p_1 - p)/1 - p_1)$, have been calculated for each month; the deviations from the annual mean values for the whole period are small. A. W. L.

2022. *Relations between Magnetism and the State of the Atmosphere.* **A. Nodon.** (Comptes Rendus, 178. pp. 1378–1379, April 14, 1924.)—A brief statement, without supporting data, that there appear to exist sufficiently close relationships between the variations of the intensity of terrestrial magnetism and the state of the atmosphere (particularly as regards temperature) to make it likely that the accuracy of general and local meteorological forecasts could be sensibly increased by the use of magnetic observations in conjunction with the usual meteorological ones. M. A. G.

2023. *Solar and Terrestrial Radiation.* **A. Ångström.** (Roy. Meteorolog. Soc., J. 50. pp. 121–126, April, 1924. Report to the International Commission for Solar Research on Actinometric Investigations of Solar and Atmospheric Radiation.)—Continuous records of the total radiation received from the sun and sky have been obtained at Stockholm since July, 1922. From these the annual and daily variation of the radiation received may be obtained, and as the direct solar radiation may be computed from the time of sunshine, the variation, both of the direct and of the diffused radiation, is known. The total amount of radiation received during the day, Q_s, may be expressed in the form: $Q_s = Q_0(0 \cdot 25 + 0 \cdot 75\,S)$, if Q_0 is the amount on a perfectly clear day, and S is the time of sunshine expressed as a fraction of the greatest possible time. The total radiation received is a minimum in the afternoon of days when the sky is less than half-covered with cloud, and a maximum in the afternoon of overcast, or nearly overcast, days; this is due to the operation of convection.

The nocturnal radiation has been measured at stations where the temperatures ranged from − 30° C. to + 30° C. The results obtained show that the radiation from a black surface at a temperature between these limits may be divided into three groups of waves: (1) About 25 % of the radiation passes through the atmosphere without absorption, and is independent of the thickness of the atmosphere and the amount of water-vapour it contains; (2) about 50 % is totally absorbed by a thin layer of the atmosphere, probably in the lowest 30 m. at ordinary vapour pressures; (3) about 25 % is subjected to a variable absorption, depending chiefly on the amount of water-vapour present. A. W. L.

2024. *Meteorological Perturbations of Sea-level and Tides.* **A. T. Doodson.** (Roy. Astron. Soc., M.N. Geophys. Suppt. 1. pp. 124–147, April, 1924.)—Statistical formulæ for the correlation of wind, pressure gradient and sea-level are worked out, and the results applied to two stations—Newlyn and Liverpool. The variations at Liverpool are on a greater scale than those at Newlyn, especially in the case of wind effects. This scale relationship appears to exist even after corrections to sea-level have been made, and suggests that the residual effects are due to a common law not covered by the fomulæ used. Increased correlation between pressure gradients and sea-level at Liverpool over Newlyn is accompanied by a decreased correlation between pressure and sea-level. An investigation into time lags and the effects of Atlantic conditions is also undertaken. A high barometer makes high-water at Newlyn earlier than would be anticipated. W. A. R.

2025. *Distribution of Earth Density.* **H. Jeffreys.** (Roy. Astron. Soc., M.N. Geophys. Suppt. 1. pp. 121–124, April, 1924.)—Radau's transformation is applied to test the theories of the distribution of density within the earth. Wiechert's discontinuous zones are theoretically impossible—it is an extreme case in which all variation takes place at the discontinuities. Laplace's and Roche's hypotheses represent the other extreme in which the variation is continuous. The actual variation is probably intermediate in character, and the Radau approximation having been proved valid for extremes is probably correct for actual cases. W. A. R.

2026. *Earth Shrinkage and Diminishing Rotation.* **R. Stoneley.** (Roy. Astron. Soc., M.N. Geophys. Suppt. 1. pp. 149–155, April, 1924.)—Diminishing centrifugal force due to the slowing down of the earth's axial rotation is a qualitatively competent cause of orogenic movements. Investigation of the conditions shows that the tangential stress differences thus set up are about three times as great as the strength of the surface rocks. The effects of long-continued action and heterogeneity must be taken into consideration, and then it would appear that little or no mountain building could arise from the cause postulated. W. A. R.

2027. *Earthquake Periodicity.* **H. H. Turner.** (Roy. Astron. Soc., M.N. Geophys. Suppt. 1. pp. 105–120, April, 1924.)—An inequality period of four years was noticed in Jamaican earthquakes. The long series for China and Japan gave together a mean of 3·983 years, and, since no other series is so long, this has been adopted for use. Other localities indicate a similar period, and when tabulated a regular march in latitude is clearly seen. The most suitable hypothesis seems to be a regular travel of the maximum from the South Pole to the North in a four-year cycle. Magnetic results were also examined, and the period affecting them is rather greater than nine years, and must have a different origin. [Abstract 1335 (1923).] W. A. R.

LIGHT.

2028. *Molecular Roughness of a Mercury Surface.* **R. Gans.** (Ann. d. Physik, 74. 3. pp. 231–251, May, 1924.)—Owing to thermal oscillations a mercury surface is not perfectly plane. The reflection and scattering of light from such a surface is dealt with mathematically. A. A. D.

2029. *Light Absorption in Space.* **A. Kopff.** (Zeits. f. Physik, 23. 6. pp. 411–416, 1924.)—This paper is a detailed reply to Kienle's criticisms [see Abstract 1113 (1924)] of the author's former paper on Light Absorption in Space [see Abstract 53 (1924)]. The latter, in concluding his reply, expresses the opinion that the differences between them had arisen from mutual misunderstandings, and that his present paper will have cleared these away. G. W. de T.

2030. *Approximate Refractive Index of Liquids by Means of a Microscope.* **C. C. Kiplinger.** (Chem. Soc., J. 125. pp. 963–965, April, 1924.)—If a small spherical lens be placed in contact with a microscope slide, the lens brought under the objective, and the whole system focussed on an object 1 or 2 feet away from the microscope, the introduction of a drop of liquid between the spherical lens and the slide causes a change in the focus of the optical system. The magnitude of this change being approximately proportional to the refractive index of the liquid introduced, the value of the index may be inferred from the change produced by any given liquid as compared with that produced by a convenient liquid of known index. A convenient method for making the spherical lens is described, and the results of some measurements made by the method are given. J. W. T. W.

2031. *Improved Radiometer Construction.* **J. D. Tear.** (Phys. Rev. 23. pp. 641–648, May, 1924.)—The sensitivity of the Nichols radiometer was increased by a factor of five by attaching "pearled" mica shields immediately behind the vanes. Optimum spacing of vane and shield was experimentally determined. Further increase in sensitivity was obtained by increased lightness of construction and by choice of dimensions and working conditions. Deflections were found proportional to energy, and the sensitivity per unit area proved independent of vane width for vanes less than $1 \cdot 5 \times \cdot 5$ mm. The most efficient fibre was found to be one which gives a half-period equal to the desired deflection time, and the best gas pressure that which gives critical damping. The sensitivity obtained is $2 \cdot 1 \times 10^{-8}$ watts/cm.^{2} for 1 mm. deflection. Thin platinum films make good absorbing surfaces for radiometer vanes. *Absorption of long infra-red waves by thin platinum films* was found to reach a sharp and high maximum for a definite thickness, which, however, varies with the wave-length. Author.

2032. *The Effective Wave-length in White-light Interferometry.* **F. Allison.** (Astrophys. J. 59. pp. 210–227, May, 1924.)—A mathematical theory of the form of the interference fringes from a single source is developed. The theory is then illustrated by some computed instances.

It is shown how this theory can be combined with experiment for the purpose of obtaining the effective wave-length for any double star of known black-body temperature. Good agreement is found between the values obtained by the present method and Anderson's experimental value for sunlight. AUTHOR.

2033. *The Optical Refraction in Gases in the Spectral Region between 5782–2442 Å.U.* **B. Quarder.** (Ann. d. Physik, 74. 3. pp. 255–274, May, 1924.)—Exact dispersion data for mono- and poly-atomic gases are of great importance for the extended development of the quantum and modern atomic theories. The present paper investigates to what extent in the ultra-violet region measurable interference bands can be obtained by means of the Michelson interferometer using fluorspar plates. A limit of about 2400 Å.U. was reached. Very complete apparatus and procedure details are included. The dispersion of dry air free from carbonic acid was determined between 5782–1618 Å.U. and of argon between 5782–2442 Å.U. The experimental data expressed as dispersion formulæ are:—

$$\text{Air}: \nu_0 . 10^7 = 2879{\cdot}87 + 18{\cdot}04 \times 10^8/\lambda^2$$

$$\text{Argon}: \nu_0 . 10^7 = 2778{\cdot}26 + 15{\cdot}88 \times 10^8/\lambda^2.$$

H. H. Ho.

2034. *Optical Dispersion and Selective Reflection, with Application to Infra-red Natural Frequencies.* **T. H. Havelock.** (Roy. Soc., Proc. 105. pp. 488–499, May 1, 1924.)—In a previous paper [see Abstract 836 (1912)] the author gave a comparison of the maxima of absorption and reflection as deduced from optical dispersion formulæ of various types. Exact equations, together with approximate solutions, were found for the maxima of k and of nk, and for the minima and maxima of n. The maximum of reflection was found by numerical and graphical methods in certain cases, both in the ultra-violet and in the infra-red. The infra-red frequencies of substances like rock-salt are of special interest in view of the various methods now available for estimating them from the view-point of crystal structure. The frequencies so calculated have generally been identified with the frequencies of the residual rays in the same region. Thus Born, using the dynamics of a simple crystal lattice, compared the natural wave-length with the maximum of selective reflection as given by residual rays; later, allowance was made for the difference between these wave-lengths, and an approximate formula given by Försterling was used in making the correction. In this paper the author extends his previous study of dispersion formulæ by obtaining an exact equation for the maximum of selective reflection in terms of the constants of the formula; in addition, a simple approximate solution of the equation is given. It appears, incidentally, that the approximate formula due to Försterling is incorrect. The results are applied in the first place to a study of various dispersion formulæ for rock-salt, sylvin, and fluorspar. Further, assuming the data of crystal dynamics, some calculations are made to show to what extent the results affect the comparison between the resonance wave-length so obtained and the wave-length of residual rays. H. H. Ho.

2035. *On the Image produced by a Thin Exactly Normally Incident Pencil upon a Refracting Spherical Surface Cut by Perpendicular Axial*

Planes. **M. Sundquist.** (Zeits. Instrumentenk. 44. pp. 198–217, May, 1924.)—This paper is entirely geometrical, and treats the above problem very fully as a contribution to experimental optics. The mass of mathematical detail renders an abstract impracticable. H. H. Ho.

2036. *The Permeability of Synthetic Resin to Infra-red Radiations.* **G. Kimpflin.** (Comptes Rendus, 178. pp. 1709–1711, May 19, 1924.)—The behaviour of the synthetic resin obtained by condensation of phenol under the action of formic aldehyde by Baekeland's method (bakelite) has been investigated. The transparency in the infra-red varies with the nature and proportion of the substances mixed with the bakelite; it varies inversely as the thickness of the plate used. The following are the observed transparencies for plates 5 mm. thick: Pure bakelite, 35 per cent.; bakelite containing colloidal iron (2 parts in a 1000 of ferric chloride added before polymerisation), 34 per cent.; bakelite with 10 per cent. of manganese dioxide, 6·7 per cent.; bakelised paper, 17 per cent. A plate of ebonite 5 mm. thick transmits only 3 per cent. It is possible that bakelite may be of use in several technical cases (*e.g.* signalling with infra-red light). **Erratum** (*Ibid.* p. 1931, June 2, 1924.) H. N. A.

2037. *Optical Collineation without Reference to Metrics.* **L. Silberstein.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 675–680, May, 1924.)—A generalised treatment of the Möbius-Abbe optical collineation, in which the optical problem is treated entirely by the methods of projective geometry so that the investigation is independent of the usual metrical concepts of length or angle (and therefore also of parallelism or orthogonality), and, in particular, of the metrical nature of the hypothecated space. J. W. T. W.

2038. *Spark Apparatus.* **C. Leiss.** (Zeits. f. Physik, 23. 5. p. 333, 1924.)—In work with spark spectra it is frequently desirable to use sparks between different electrodes in quick succession. An instrument is described which enables eight separate pairs of electrodes to be used in quick succession without altering the position of the spark relative to the collimator slit. G. A. S.

2039. *Properties of Optically Active Media.* **H. Chipart.** (Comptes Rendus, 178. pp. 1532–1534, May 5, 1924.)—Mathematical. J. W. T. W.

2040. *A Primary Standard of Light.* **H. E. Ives.** (Frank. Inst., J. 197. pp. 147–182, Feb., and pp. 359–400, March, 1924.)—A really satisfactory primary standard of light has not yet been produced. What is required is in general some source of luminous energy whose construction can be accurately specified and reproduced, and whose luminous output shall be fixed by the specified construction with a definiteness comparable with the accuracy attainable in the best methods of photometric measurement.

This paper gives a full account of the development of a special design of platinum black body and a study of its performance. A complete series of 69 observations is described, both visual and photoelectric. For the final value the visual and photoelectric series are given equal weight, leading to the following value for the brightness of the platinum body at its melting-point: $b = 55{\cdot}40 \pm 0{\cdot}11$ candle-power per sq. cm. The performance of a cylindrical form of black body made of platinum to certain specified dimensions, and observed at its melting-point, is compared with the behaviour of the only practical flame standards, the Hefner and pentane lamps. The new platinum standard, considered from the standpoint of precision of setting, is notably better than the flame standards. One great advantage over any flame standard which it possesses is its freedom from atmosphere influences, since both the pressure and humidity ranges in the atmospheric are too small to affect the melting-point of platinum to an observable extent. Next, the relative simplicity of this standard is to be considered, and its easy reproducibility. It is very much simpler than the pentane lamp, though not so simple as the Hefner lamp. The last point to be considered is the suitability of the light from the platinum black body for accurate photometric measurement. In respect to colour, the condition is ideal, because of the match with the carbon incandescent lamp maintaining standards. Moreover, as regards intensity, the new standard leaves little to be desired. Granting the use of a suitable photometric procedure, the platinum black body meets the requirement of being easily and accurately measurable. Two sources of error, which are readily apparent, may be expected to make the measured brightness lower than for a true black body. These are: Deviation of the platinum surface from true specular character, whereby the practically complete blackness indicated by calculation is not attained; and irregularities of temperature around the cylinder, which will melt at the point of highest temperature, while the emission will be a function of the average temperature. The platinum black body described forms a new kind of standard "lamp," and it is also a realisation of the proposal of Waidner and Burgess which was the inspiration of the work. The paper is fully illustrated by numerous diagrams, reproductions of photographs, and tables giving the results of the observations made. J. J. S.

2041. *Auto-Registering Optical Micrometer for a Prism Astrolabe.* **R. Baillaud.** (Comptes Rendus, 178. pp. 1472–1474, April 28, 1924.)—Near the objective of a telescope, and between the objective and the eye-piece, two sheets of glass, of the same thickness and index of refraction, and with their faces plane and parallel, are placed perpendicular to the vertical plane passing through the vertical optical axis of the telescope. The first is movable round the horizontal axis situated in its plane; the second is fixed. The author describes the means by which personal equation, unequal refraction, and other systematic errors may be obviated by this device, as in a meridian instrument by means of a micrometer with a movable thread. A. S. D. M.

2042. *New Type of Photometric Disc.* **E. Karrer.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 541–543, April, 1924.)—Two small synchronous motors are used, upon the axes of which are mounted the two discs, these having their planes parallel and their axes in line. The motors are operated from the same circuit, and so the discs run in unison. One of the motors is mounted so that its stator may easily be tuned through any angle. In this way the relative aperture through the two discs may be varied whilst they are running. A. A. D.

2043. *Measurement of Visibility.* **A. Wigand** and **K. Genthe** (Phys. Zeits. 25. pp. 212–223, May 1, 1924.)—Describes a development of the instrument previously described [see Abstract 1000 (1919)], with particular reference to (*a*) the evolution of empirical formulæ to render the measurements independent of the distance or size of the target, (*b*) the determination of the amount of variation likely to be introduced into the measurements by the use of a telescope or by uncorrected defective vision in the observer. J. W. T. W.

2044. *Formulæ for Oblique Focal Distance in Terms of Magnification.* **[Miss] A. Everett.** (Phil. Mag. 47. pp. 864–873, May, 1924.)—Gives a formal proof of T. Smith's formulæ for finding the position of either member of a pair of conjugate primary foci, in terms of the magnification, on a ray traced through a coaxial lens system [see Abstract 926 (1918)]. J. W. T. W.

2045. *A New Tri-Colour Mixing Spectrometer.* **F. Allen.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 339–341, Feb., 1924.)—The new instrument, of which a brief description is given in this communication, is a combination in part of the colour-mixing spectrometer described by Helmholtz (Physiol. Optik, 3rd Ed., 2. p. 333), and of the Hilger wave-length spectrometer. The plan of the instrument is shown in detail in two figures. It was designed and constructed from the author's sketch-plans by Adam Hilger, Ltd. J. J. S.

2046. *The Beneze-Wolf Fibre Polar Planimeter.* **K. Oltay.** (Zeits. Instrumentenk. 44. pp. 217–229, May, 1924.)—In the leather industry it is necessary to know the surface content of separate pieces of leather of irregular shape, and planimeters are employed for this purpose. The Beneze-Wolf planimeter, now described in detail, is a type of polar planimeter with variable arm length, and differs from types hitherto in use by the provision of a steel flexible fibre in place of the rigid arm, and by conducting the final measurement at the circumference of the test-piece. The principle of the instrument is fully described and accompanied by eleven illustrations. Tables of data are included to emphasise the accuracy and utility of the instrument. H. H. Ho.

2047. *Automatic Feeder for Coloured Flames.* **J. J. Manley.** (Phil. Mag. 47. pp. 859–864, May, 1924.)—The flame of a Meker burner plays upon a portion of the circumference of a platinum ring which rotates in a horizontal plane in contact at another part of the circumference with a salt-charged wick. The spurting due to an unrestricted flow of salt solution to the flame is thus avoided, and a steady, brilliant coloured flame results. The rotation of the ring is accomplished by means of a vane system operated by the convection currents from the burner. G. A. S.

2048. *An Investigation of the Field in a Hand Telescope by the Method of Banded Images.* **A. Wetthauer.** (Zeits. Instrumentenk. 44. pp. 189–198, May, 1924. From the Reichsanstalt.)—The quality of the telescopic field deteriorates from the centre towards the edge, and this becomes pronounced for great magnifications. The present paper contains a quantitative investigation of the errors which arise in the field of view, and for this purpose the method of banded images has been employed photographically [see Abstract 116 (1922)]. The paper, which is amply illustrated, is so full of experimental detail as to necessitate the original being consulted for an adequate account. H. H. Ho.

2049. *Opaque Illuminators for High-Power Microscopes.* **C. Beck.** (Journ. Sci. Instruments, 1. pp. 238–242, May, 1924.)—The author describes two new forms of illuminator for the examination of opaque objects by high powers. The aplanatic ring illuminator is shown in Fig. 1. A form of annular mangin mirror is used to concentrate light on the object. This type of illuminator is adapted to oil immersion object glasses by constructing the whole front mounting in glass instead of in metal. This form is shown in Fig. 2. A new form of variable vertical illuminator with interchangeable mirrors is also described. The relative advantages of the two systems, *viz.* vertical illumination and outside illumination are discussed. The latter system is free from glare or ghosts, and it is preferable when the object is mounted on glass. J. W. T. W.

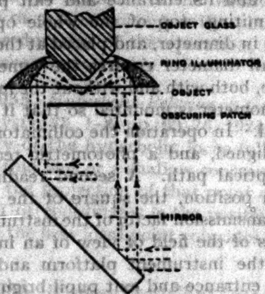


FIG. 1.

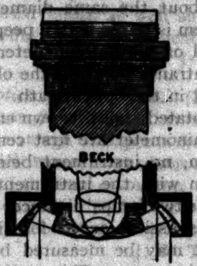


FIG. 2.

2050. *Quartz Spectrograph for Wave-Lengths to* 1850 Å. **E. O. Hulbert.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 707–709, May, 1924.)—This is a description of a quartz spectrograph mounted in the Littrow manner. The prism of angle 30° is backed by a reflecting surface of mercury. The spectrum length from 2800 to 1850 Å. is about 77 mm. Various practical points are touched on, and the performance of the instrument is illustrated by two photographs. A. A. D.

• **2051.** *The Measurement of Transmission of Light in Instruments.* **G. W. Moffit and P. B. Taylor.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 511–518, April, 1924.)—A description is given of a transmission photometer to compare the actual brightness of a distant object with the brightness of its image as seen through the instrument under test. The instrument consists essentially of a collimator which furnishes an effective distant source, a platform on which the instrument whose transmission is to be measured is placed, and an illuminometer modified by the addition of a short focus objective and a ground-glass exit pupil screen. The collimator carries a 7·5 cm. achromatic objective of about 45 cm. focal length. The radiating disc of opal glass located at the principal focus of this lens is provided with a sliding diaphragm having holes so graduated as to enable compensation for the magnification of the instrument under test to be effected.

The collimator is mounted on a bench along which it can be moved.

In order to facilitate alignment, the platform is so arranged that, when it is rotated, the instrument under test rotates about its exit pupil. The illuminometer contains the usual Lummer-Brodhun cube, comparison lamp and scale. The objective is about 7 cm. focal length, and so arranged as to focus an image of the distant source in the field of view. The focal lengths of the objective and eye-piece being the same, the magnification by the illuminometer is about unity, and its entrance and exit pupils of about the same diameter. The limiting stop of the whole optical system is a disc with a peephole 2 mm. in diameter, and placed at the exit pupil of the illuminometer. This small diameter ensures the same size of entrance pupil for the observer's eye, both with and without the instrument in the optical path. The illuminometer is mounted so that it may be rotated about its own entrance pupil. In operation the collimator and illuminometer are first centred and aligned, and a photometric reading taken, no instrument being in the optical path. A second reading is taken with the instrument for test in position, the square of the ratio of the two lamps' distances being the transmission factor of the instrument. Transmission factors for different parts of the field of view of an instrument may be measured by rotating the instrument platform and the illuminometer. This method and the entrance and exit pupil brightness method are compared, and the authors find that the former measures more nearly correctly the real image-forming transmission, and that a large amount of flare and scatter will not be mistaken for actual transmission of image-forming light [see Abstract No. 2261 (1922)]. W. C. S. P.

2052. *Influence of a Magnetic Field on the Polarisation of the Resonance Light.* **G. Joos.** (Phys. Zeits. 25. pp. 130–134, March 15, 1924.)—Referring to the paper of R. W. Wood and A. Ellett on the influence of a magnetic field on the resonance light of mercury and sodium vapours, the author points out that the polarisation of the resonance light is a consequence of the Zeeman effect, and can be fully explained in this way. The fact that in the absence of every field the resonance light produced by suitably polarised light is itself polarised is strongly in favour of the hypothesis that the atom orientates itself relatively to the light ray. J. J. S.

2053. *New Interference Phenomenon.* **F. Wolfers.** (Comptes Rendus, 178. pp. 1704–1706, May 19, 1924.)—The author announces a new phenomenon originally noticed with X-rays [see Abstract 2197 (1923)], but now repeated with light. The penumbra between the geometrical shadow of a cylindrical screen and the first true diffraction band will, if examined microscopically, show one or more bands, which are described in the paper. These the author attributes to interference between (*a*) the direct and normally diffracted light, and (*b*) the light diffused by resonators at the edge of the screen. J. W. T. W.

2054. *Application of the Law of Weber-Fechner to Photometry.* **P. Lasareff.** (Rev. d'Optique, 3. pp. 65–70, Feb., 1924.)—The law of Weber-Fechner does not apply to very feeble illuminations except on condition of taking into account, as Fechner has already done, subjective luminous sensations, under the form of a term additive to the intensity of the observed light. Helmholtz has perfected the theory in taking account of the dimensions of the illuminated retinal surfaces, and has thus obtained a more general formula, that the experiments of König and Brodhun have indeed verified for feeble intensities. Returning to intensities not very small, the author has proved that the way in which this equation of Helmholtz brings in the dimension of the retinal field does not take account of experiment. He proposes a rectification of the formula which holds at least in the case of reduced fields; then he considers and defines the influence of the distance and the mutual position of the two fields of comparison upon the photometric sensitiveness, as well as that of the duration of the operation, the whole being specially applicable in the case of small fields. J. J. S.

2055. *Hyperbolic Relation in Geometrical Optics.* **S. Bodócs.** (Zeits. f. Physik, 23. 1–2. pp. 69–76, 1924.)—The author gives the mathematical theory of the hyperbolic locus followed by the image of a point formed by a thin lens or a shallow concave mirror, which moves towards or away from the projection of that point on the axis of the lens or mirror. The origin of coordinates is the position of the second focal point of the lens when the first focal point coincides with the projection of the object-point. J. W. T. W.

2056. *Rotatory Crystalline Dispersion.* **L. Longchambon.** (Comptes Rendus, 178. pp. 1828–1831, May 26, 1924.)—When an active substance passes from the liquid or dissolved state to the solid condition, a considerable variation is generally found in the rotatory power, sometimes accompanied by change of sign. On the other hand, the author has shown that the rotatory dispersion appears to remain constant. Work is now described for coloured substances whose dispersion anomalies permit of very appreciable comparison, and results are included for potassium rhodo-trioxalate, a beautiful red substance which crystallises in the rhombohedral system with the symmetry of quartz, whose aqueous solutions are remarkable for their intense rotatory power and anomalous dispersion. Jaeger's work is referred to. This identity of dispersion in the case of transparent substances and the relationship of the dispersions now found for coloured substances are shown to receive a simple explanation on Drude's theory. The phenomena found are analogous to those given by Bruhat for diphenyl-1-bornylimidoxanthide. H. H. Ho.

2057. *Light-Scattering in Turbid Media.* **A. Carrelli.** (Zeits. f. Physik, 24. 1. pp. 37–40, 1924.)—When polarised light is passed through a turbid medium and the scattering examined in different directions perpendicular to the primary beam, not only the normal Tyndall effect, whose intensity is a maximum in a direction perpendicular to the plane of the electric vector in the primary beam, is observed; an additional scattered beam is found in the direction of the plane of the primary electric vector. This beam is considerably richer in short waves than the proper Tyndall effect, and its electric vector is in a plane parallel to that of the primary beam. When the particles are few in number and small the effect is not observable. When they have grown, the beam in question is completely polarised. With still larger concentrations polarisation is no longer complete. The theory of the effect is discussed. G. A. S.

2058. *Examination of Crystal Sections by Conoscopic Methods: Convenient Source of Sodium Light.* **C. W. Hawksley.** (Phys. Soc., Proc. 36. p. 210, April, 1924.)—Describes a simple optical arrangement which can

be conveniently fitted to an ordinary microscope, and which has been specially designed to increase size and definition of the interference rings observed when uniaxal or biaxal crystals are examined in convergent polarised light. A convenient source of sodium light is also described.
J. W. T. W.

2059. *Optical Projector for Showing Irregularities of Surface.* **H. Bénard.** (Rev. d'Optique, 3. pp. 127–136, March, 1924.)—Describes a form of optical apparatus designed for showing the honeycomb appearances presented by a thin layer of liquid supported on a flat plate heated from below [see Abstract 2078 (1901)]. The system is fully described in the paper, together with the details of a particular apparatus used for demonstrating this phenomenon at the T.S.F. exhibition. The method may be extended to the study of the small changes of refractive index or of thickness which a liquid layer may show. J. W. T. W.

2060. *Photoelectric and Photochemical Activity.* **O. W. Richardson.** (Phil. Mag. 47. pp. 975–976, May, 1924.)—The conditions under which a formula for the photoelectric activity of radiation, developed by the author prior to and independent of the publication of Bohr's theory, may be effectively identified with a formula arrived at by Kramers and Milne [see Abstract 833 (1924)] are discussed. A. B. C. L.

2061. *The Development of the Latent Image after Fixing.* **L. Lumière, A. Lumière** and **A. Seyewetz.** (Comptes Rendus, 178. pp. 1765–1771, May 26, 1924.)—Some notes are given relative to the process and the results of fixing the photographic plate before its development. Particulars are given of the fixing and developing solutions; in the case of the former a solution of sodium hyposulphite and ammonia is employed. A series of photomicrographs is given, illustrating the effect upon grain size of the duration of development after fixing. In the case of the Lumière gelatine bromide plate used, there is a marked reduction of grain size when development is continued for one hour after the plate has been fixed, as compared with the results of the normal development with diamidophenol. The size of grain is shown to increase progressively with time of development, after fixing has occurred, the longest development period in the present case being 48 hours. Intensification of the silver image by mercuric iodide after the process of development following fixing is shown to result in an appreciable increase in grain size. It is shown also that the method of development after fixing enables very fine grain effects to be obtained from both fast and slow plates. A. W. J.

2062. *Radio-luminescence and Radio-photoluminescence. Part II.* **K. Przibram** and **Elizabeth Kara-Michailova.** (Akad. Wiss. Wien, Ber. 132. 2A. No. 7–8. pp. 285–298, 1924.)—The previously raised question whether the radio-photoluminescence is completely a lighting-up (raising of the central temperature), in Lenard's sense, or may not be partially also a pure excitation (action of photoelectric electrons), has hitherto not been thoroughly decided. Radio-photoluminescence, which is probably due to energy furnished by the β-γ-radiation, is exhibited by kunzite even fifteen years after the action of radium radiation upon it. Kunzite is also through spark-light excited to longer after-illumination; a lighting-up by visible light cannot in this case yet be established. Several specimens of fluorite, which in the natural condition in visible light show either blue fluorescence or none at all, give, after the radium radiation, during the illumination, beautiful red fluorescence (momentary radio-photoluminescence). The brightness of the luminescence of some fluorite in connection with its dependence upon the duration of the radium radiation has been photometrically measured; the curve exhibiting a maximum may to a first approximation be expressed in the form: $J = A(1 - e^{-\lambda_1 t}) + B(e^{-\lambda_2 t} - e^{-\lambda_1 t})$, which theoretically simply expresses the excitation, falling-off and dissipation of the centres. By means of a photo-cell the light sum due to radium radiation is measured as a function of the duration of radiation; for the first the earlier obtained result is established; for the latter a decrease of the light sum with longer radiation is shown. Photoelectric measurement of the radio-photoluminescence in light distributed in the spectrum gives in verification of the earlier communication only a maximum, and for kunzite between 525 and 550 $\mu\mu$, for fluorite from Sarutal at 450 $\mu\mu$, for a fluorite from Oberkirch and apatite from Auburn similar results. J. J. S.

2063. *Fluorescence of Æsculin Solutions.* **(Miss) M. B. Kearney.** (Phil. Mag. 47. pp. 648–656, April, 1924.)—J. Perrin suggested in 1918 that the emission of fluorescence by organic substances is due to the flashes of exploded molecules. Then a molecule which has once emitted fluorescent light would have completely lost its power of fluorescence. R. W. Wood, transforming fluorescent solutions by concentrated sunlight, found no satisfactory confirmation of Perrin's theory, nor did Pringsheim [Abstract 1990 (1922)] in his experiments with fluorescein and eosin. Kautsky and Zocher [Abstract 154 (1923)] by their results support Pringsheim's views, especially in regard to the dependence of the phenomenon on temperature. M'Lennan and Cole have recently shown that an aqueous solution of æsculin can be made to fluoresce for a long time without destruction of its fluorescence when excited by light of suitable wave-length. The author of the present paper has extended the work of M'Lennan and Cole, using as a standard solution 4 parts of æsculin to 100,000 parts of solvent by weight. The intensity of the fluorescence emitted by a solution of strength 8/100,000,000 could be measured. The æsculin was dissolved in various solvents. The following are the principal results attained: (1) The initial fluorescent intensity of a solution depends on the solvent used; it is greater for aqueous solutions than for organic solutions of the same concentration. (2) For solutions of equal concentration the initial rate of transformation by ultra-violet light and ozone is greater for organic than for aqueous solutions, but organic solutions require a much longer exposure for complete transformation. (3) The presence of a solvent is essential for the transformation of æsculin; ultra-violet light and ozone produce no change in æsculin powder. (4) Verification has been obtained of the previously ascertained fact that a solution can be made to fluoresce without being destroyed by exposing it either in an evacuated glass tube, or in a quartz tube surrounded by a transformed solution. Thus (the extreme ultra-violet rays being cut off) it is shown that the decay of the fluorescent intensity is due to the action of the extreme ultra-violet region. J. J. S.

2064. *Relations between Supplied Energy, Spectral Intensities and Alterations in Different Media.* **L. Hamburger.** (Am. Electrochem. Soc., Trans. 44. pp. 271–282, 1923.)—The conception of the unity of optical, chemical, and energetic relations laid down in the quantum theory, and the Rutherford-Bohr interpretation of atomic structure, does not admit of an essential difference between chemical and physical changes. The author, using the photographic method indicated by Holst and Hamburger, has obtained results for simple gases that showed for every spectrum line (except the argon spectrum) or band that the emission is always proportional to the supplied energy. From these results and a consideration of data on the negative glow, the luminescent arc discharge, and the single line spectrum, it is now concluded that in general there is, in widely differing kinds of electric discharges in gases, always proportionality of the occurring radiation and electro-chemical or photo-chemical reactions with the supplied energy, provided the variables are kept within those limits in which the character of the bearers (luminiscence centres) remains unmodified. In mixtures of gases, for which chemical action is conceivable, chemical action takes place at electrical discharge, which action always manifests itself also spectrographically. Dislocated—that is, excited or partially ionised—atoms play important parts in the explanation of electroluminescence effects observed on collisions between slow electrons and atoms, spectra not electrically excited, catalytic phenomena, and reaction velocities. Regarding the latest category by way of example, the dependence of the reaction temperature on the nature of the metal carbonate used in the cyanide process for the fixation of nitrogen is explained with the aid of the ionising and resonance potential data for the alkali and alkaline earth metals. H. H. Ho.

2065. *The Quantum Theory of Radiation.* **N. Bohr, H. A. Kramers and J. C. Slater.** (Phil. Mag. 47. pp. 785–802, May, 1924. Zeits. f. Physik, 24. 2. pp. 69–87, 1924.)—An attempt is made to arrive at a consistent description of optical phenomena by connecting the discontinuous effects occurring in atoms, involved in the quantum theory of the exchange of energy and momentum between matter and radiation, with the continuous radiation field involved in the wave theory of light. Einstein's applications of probability laws to the study of the "stationary" states of atoms and the transitions of atoms from one stationary state to another are fundamentally introduced into the argument, which is specially developed to embrace the study of the capacity of interference of spectral lines and the quantum theory of spectra and optical phenomena.

A. B. C. L.

2066. *Poynting's Theorem and Ray Propagation in Optically Active Media.* **H. Chipart.** (Comptes Rendus, 178. pp. 1805–1808, May 26, 1924.)—From Poynting's theorem, in which the light rays are regarded as the lines of energy flow, it follows that the radiation vector is the product of the radial velocity and the electromagnetic energy. Optically active media being essentially dispersive, it is necessary to investigate whether the velocity to be taken is the velocity of phase or the velocity of amplitude. The author shows, by mathematical treatment given in the paper, that the latter is the velocity demanded. J. W. T. W.

2067. *Electromagnetic Theory of Rotatory Polarisation.* **H. Chipart.** (Comptes Rendus, 178. pp. 1969–1971, June 10, 1924.)—A continuation of previous work [see Abstract 1151 (1924)], extending the validity of Poynting's equation to the boundary of an optically active medium.

J. W. T. W.

2068. *The Polarization of Resonance Radiation.* **G. Breit.** (Phil. Mag. 47. pp. 832–842, May, 1924.)—A quantitative elaboration of the consequences of the Zeeman effect in resonance radiation is shown to give polarisations in fair agreement with the observed values of Wood and Ellett for sodium in a strong magnetic field, or in the absence of a field. Einstein's considerations [Abstract 654 (1917)] are used as a basis of the calculations. If considerations similar to those applied to sodium should be carried out for mercury, similar results would be obtained, whereas Wood and Ellett find 90 % polarisation in the absence of a magnetic field, the corresponding value for sodium being 5 %. This result seems to imply that the incident wave has orientating influence on the " corresponding " radiating mechanism. The value of H, which suffices to establish the space quantizing appropriate to a magnetic field, is tentatively brought into connection with the period of the Larmor precession as compared with the time constant τ of the atom. Numerical agreement is attained in the case of mercury if $\tau \cong 10^{-6}$ sec. rather than 10^{-8} sec. Evidence in favour of 10^{-6} of a second is adduced. It is suggested that not all collisions are effective in causing fluorescent emission, since this also explains the measurements of Wood on the time lag of fluorescence in mercury vapour. The case of sodium is treated on the assumption that $\tau \cong 10^{-8}$ sec. W. V. M.

2069. *The Thermal Equilibrium between Light Waves and Sound Waves.* **E. Schrödinger.** (Phys. Zeits. 25. pp. 89–94, Feb. 15, 1924.)—Brillouin [Abstract 1131 (1922)] has shown, on the basis of classical considerations, that a light wave of length λ will suffer some amount of regular reflection from an advancing sound wave of length L. The case is similar, in fact, to reflection from a lattice, and in the ordinary way one obtains the well-known Bragg formula $2L \sin \theta = \lambda$ for a reflection of the first order. In the present paper the same formula is obtained on the basis of the quantum theory. This result is applied to the equilibrium conditions which hold when radiation traverse a medium, the molecules of which possess thermal energy of vibration. For the thermal energy of vibration may be resolved into a series of sound waves, and the formula derived above applied to all the energy exchanges which occur. Along these lines and on the basis of certain assumptions, two methods are given to prove that under equilibrium conditions Planck's distribution law holds.

A. A. D.

2070. *Radiation Law and Intensity of Multiple Lines.* **L. S. Ornstein and H. C. Burger.** (Zeits. f. Physik, 24. 1. pp. 41–47, 1924.) —Previous measurements of the intensities of the components of multiple spectral lines led to results that could be expressed by certain empirical rules [see Abstracts 1454 and 1455 (1924)]. In the present paper the theoretical significance of these expressions is investigated, and the above intensities are brought into simple relationship with the statistical constants of the states and the conceptions of emission and incidence probability which have been introduced by Einstein into the radiation theory.

H. H. Ho.

2071. *Interpretation of Dispersion on the Quantum Hypothesis.* **K. F. Herzfeld.** (Zeits. f. Physik, 23. 6. pp. 341–360, 1924.)—The formulation of a dispersion theory on the assumption that light consists of quanta instead of continuous waves is possible if one assumes that atoms can arrest such quanta as do not fulfil the Bohr frequency condition, and after a short time again emit them in the original direction or scatter them to the side. The delayed energy propagation postulates the arrestment of quanta emitted in a forward direction; the altered phase propagation postulates the modification in movement of the shared electrons indicated by Wentzel [Abstract 1435 (1924)]. For such quanta as do not fulfil the Bohr condition the time of arrestment must be of the order of $1/\nu$; for such as do fulfil it it must be about 10^{-8} seconds. It is shown further that energy equilibrium exists between radiation and matter.

G. A. S.

2072. *Radiation.* **W. P. Davey.** (Frank. Inst., J. 197. pp. 439–478, April, 1924.)—Radiations classed as wave-motions are such as cannot be affected by the presence of an immaterial agent, such as an electrostatic or a magnetic field in their paths, and are usually considered to differ from each other only in wave-length, *e.g.* radio, infra-red, visible light and ultra-violet light waves, X- and γ-rays. Knowledge of them is based on experiments which deal either with the material substances in the source of the "waves," or with material substances interposed in their path, *i.e.* the study of these radiations is really that of the nature of the atoms of material substances and of interactions between these atoms and radiation. Many branches of physics and chemistry have contributed to such study, and it is the purpose of the present paper to show what these contributions are, and how they are related to the general problem of radiation. Section A discusses material substances as sources of radiation, and commences by considerations based on experiments which are not directly connected with radiation. The work of Thomson, Rutherford, and Aston is briefly reviewed, following which come discussions of the static atom from chemical and physical view-points, the configurations of electrons, the ionising potentials of static atoms, and compressibility of metals. It is shown that a law of force of the type necessary to stabilise a "static" atom, and derived by Thomson, makes it possible (1) to deduce the law relating the atomic dimensions to ionising potentials, (2) to calculate the ionising potentials of various elements, and (3) to calculate their compressibilities. Next come considerations based on experiments which have to do directly with radiation. These include black-body radiation, the theories of Rayleigh, Wien, and Planck, atomic heats, and chemical reactions. The concluding part of this preliminary paper deals with Bohr's theory. The opinion is expressed that the difference between the two atomic pictures (static and Bohr) is largely a matter of words. The expositions are to be concluded in a second paper.

H. H. Ho.

2073. *Radiation.* **W. P. Davey.** (Frank. Inst., J. 197. pp. 629–666, May, 1924.)—This paper is a continuation of a previous discussion of the subject [see preceding Abstract], and commences with an examination of the static and Bohr atoms, stating that the correspondence between the two pictures is so close that often the same terminology may be employed for both. A large mass of physical and chemical data seems to point towards the static presentation of atomic structure, such as is given by the Lewis-Langmuir atom, while data from radiation indicate the Bohr-Sommerfeld picture. By making appropriate assumptions as to the law of electrostatic force between unlike charges, and by assuming the quantum theory, the two pictures are seen to give identical results. Most experiments dealing with the material substance which finally receives the radiation are consistent with either a corpuscular or a spreading electromagnetic wave picture of radiant energy. The photoelectric and the photographic effects seem to be quite inconsistent with a spreading-wave theory, but are consistent with any form of corpuscular theory. Experiments which concern the scattering effect of material substances placed in the path of radiation are consistent with a spreading-wave theory only if proper assumptions be made as to the velocity of the scattering electron. They are all consistent with the electromagnetic dart theory, and with any form of corpuscular theory. Data on absorption and transmission, together with the absence of any effect on radiation by a pure electrostatic or magnetic field, make only one form of corpuscular theory tenable—namely, Silberstein's " dart theory "—in which darts are pictured as trains of electromagnetic waves of tiny cross-section, so that each " dart " is an entity in itself. The " dart " theory does not deny the existence of spreading electromagnetic waves such as are found in radio work, but merely assumes that the mechanism of radiation from the electrons in atoms and molecules is such as to produce tiny beams, which, by reason of some focussing action in the atom, are propagated with little or no change in cross-section. Such a theory is consistent with all known experimental facts except one, namely, diffraction from Fresnel mirrors, and, what amounts to the same thing, diffraction from a bi-prism. In view of the recent rapid progress of such a theory, due to Duane and Compton, this single remaining objection may soon be overcome. The paper contains sixty references. H. H. Ho.

2074. *The Law of Dispersion and Bohr's Theory of Spectra.* **H. A. Kramers.** (Nature, 113. pp. 673–674, May 10, 1924.)—A consistent description of the phenomena of dispersion, reflection, and scattering of electromagnetic waves by material media can be given on the fundamental assumption that an atom, when exposed to radiation, becomes a source of secondary spherical wavelets, which are coherent with the incident waves. This is briefly sketched, and the present note is preliminary to a more detailed paper later, which will show that employing the correspondence principle it is possible to obtain an adequate description of the activity of the atoms regarding their interaction with radiation. On this theory the above picture of the mechanism underlying dispersion and scattering phenomena is essentially preserved, and laws are developed connecting P (amplitude), w (a unit vector), and ϕ (phase-difference between the secondary and primary waves), which characterise the reaction of an atom in a given state against external radiation, with the peculiarities of the transitions which the atom may perform to other stationary states. The present state of the quantum theory does not allow a vigorous deduction of these laws, but a simple expression for P is established, which fulfils the condition, claimed by the correspondence principle, that, in the region where successive stationary states of an atom differ only comparatively little from each other, the interaction between the atom and the field of radiation tends to coincide with the interaction to be expected on the classical theory of electrons. Ladenburg's formula is discussed briefly, this being equivalent to the author's if a certain term be omitted, *i.e.* when only positive oscillators come into play. This term corresponds to the general case when negative virtual oscillators occur, since the atom can then perform spontaneous transitions to states with lower energy. H. H. Ho.

2075. *Doublet Separation in the Balmer Series.* **A. E. M. Geddes.** (Roy. Soc. Edinburgh, Proc. 44. 1. pp. 14–20, 1923–1924.)—Previous experiments by the author seemed to indicate a gradual decrease in the doublet separation in passing from H_α to H_β. To investigate this point further, a long tube was used, arranged so that 160 cm. of the tube could be immersed in liquid air, though only 20 cm. of the tube was actually used to illumine the slit of the spectroscope. An echelon grating of 33 plates was used. The tube was excited with an induction-coil, and exhaustion effected with a Gaede pump. H_β was obtained well separated at a particular value of the pressure, when a constant stream of gas was drawn through the tube. In liquid air the values were: H_α, 0·341; H_β, 0·362 in cm.$^{-1}$. The theoretical values are: H_α, 0·329; H_β, 0·349. A. C. M.

2076. *"Raies Ultimes" in the Arc.* **S. Procopiu.** (Comptes Rendus, 178. pp. 1368–1369, April 14, 1924.)—"Raies ultimes" appear out of all proportion to the amount of metal present as impurity, so that their non-appearance can be taken as a proof of the absence of the metal concerned. This suggests that the mechanism which produces them is different from that responsible for the emission of the lines belonging to the metal which forms the electrodes. The present paper aims at collating the facts of the appearance of "raies ultimes" in the arc.

Comparing the same arc at atmospheric pressure and at reduced pressure, in the former case the "raies ultimes" of the impurities and the flame spectra of the electrode-metal are hardly visible, while in the latter case both are strong. In air the principal cause of emission is temperature, while *in vacuo* it is some mechanism connected with the cathode. Thus, the flame lines of the metal and the "raies ultimes" of the impurities, which require little energy, will be the ones to predominate in air. If a metal contains an impurity of higher ionisation potential, then lines of the impurity should not appear, as the potential difference across the electrodes will be the ionisation potential of the metal. This does occur *in vacuo*, but not in air. This confirms the thermal origin of the "raies ultimes." A. C. M.

2077. *Band-Spectra.* **R. Fortrat.** (J. de Physique et le Radium, 5. pp. 33–50, Feb., 1924.)—A summary of the quantum theory of band spectra, beginning with the work of Deslandres. The author attempts to standardise the nomenclature in the light of the theory. A. C. M.

2078. *The Theory of Band Spectra.* **P. Tartakowsky.** (Zeits. f. Physik, 24. 2. pp. 98–116, 1924.)—The molecule is now regarded as the carrier of band spectra and the oscillation quantum number *n* for diatomic compounds is found not to exceed a certain limit inversely proportional to a constant which depends on the nature of the asymmetric union. This property, which leads to a limitation of the band spectra for diatomic molecules, is a consequence of the theory of asymmetric oscillations recently derived by the author [see Abstract 1756 (1923)], but may also be derived from the Kratzer theory of the rotation-oscillation spectra [see Abstract 861 (1921)]. A comparison between these theories is included. It has been established that the limitation to the quantum number (and to the spectra) follows from the demand that the motion of atomic systems in stationary states must possess a partial periodic character. The observation data do not contradict the theory, and the maximum values of the oscillation quantum number, as also the positions of the last upper bands, have been evaluated on the basis of considerations from ultra-red absorption spectra. The asymmetry of the oscillation appears to increase with the total number of electrons in the molecule. H. H. Ho.

2079. *Hydrogen Spectra excited by Electron Impacts.* **R. Seeliger and M. Wendt.** (Phys. Zeits. 25. pp. 160–162, April 1, 1924.)—Spectra were excited by streaming hydrogen through a tube having a hot cathode and a hollow cylindrical anode, to serve as a field-free space. The intensities of H_β, H_γ, and λ4634 (the strongest line of the secondary spectrum) were compared by photographing the lines and measuring the intensity of blackening with the Hartmann microphotometer. Curves are given for the ratio H_β/H_γ, $H_\beta/4634$ and $H_\gamma/4634$. It is found that, besides electron velocity, there are other factors which are important in affecting the equilibrium between atom and molecule (as shown by the spectra); in particular, catalytic action of the walls of the tube (as previously pointed out by Wood) and the presence of impurities, such as HCl and water-vapour. A. C. M.

2080. *Infra-red Spectra.* **H. M. Randall.** (Am. Phil. Soc., Proc. 62. 6. pp. 326–340, 1923.)—Work in the infra-red region is primarily concerned with the near infra-red region, 1 to 7 μ, and the underlying idea is to develop experimental methods which will permit the measurement of infra-red line and band spectra with such accuracy and completeness that the results may become integral parts of general spectroscopic data. The greater part of the present paper is concerned with the more recent development of methods of determining the fine structure of the absorption bands of gases and the contributions which these data make to the important problems of atomic and molecular structure. Lewis and Paschen first used gratings to analyse the characteristic radiations of gases and solids, the spectra produced being passed over a linear thermopile by rotating the grating. The presence of lines was shown by deflections of a galvanometer in series with the thermopile. Gratings of different constants are used to give maximum resolution for the particular band under examination. Thus, gratings having 20,000 lines per inch are used upon bands lying below 2 μ. This gives a spectral range of about 9 Å. upon the thermopile slit. Coarser gratings are used for bands at longer wave-lengths. Barker has ruled several echelette gratings which successfully conserve the energy in the regions of the bands investigated. The effectiveness of this method, which uses the maximum resolution a series of graded gratings can give, is illustrated by a discussion of some recent results obtained by Ångström and Palmer, by Burmeister, and by Brinswade and Kemble. The researches commented upon, while primarily experimental, were all undertaken on account of the promise they offered of giving very definite and exact information of the structure of the molecular systems taking part in the absorption. The great success of the Bohr atom in accounting for line spectra requires the application of the same ideas to molecular radiation. Thus, the molecules are supposed to exist in a number of stationary states, during which they neither absorb nor radiate energy. In the case of molecules, three kinds of transitions are possible, one electronic and two atomic. The molecule may store energy both by the vibrations which may exist between its component atoms and by its rotation about one or more axes. The three types of transitions offer through their possible combinations, together with the coupling effects, great opportunities for explaining even so complicated spectra as band spectra. The bands in the near infra-red appear to be due to the two atomic transitions alone. This paper endeavours to show in a qualitative way only how the characteristics may be accounted for by using ideas developed largely to account for the characteristics of atomic radiation as shown by line spectra.

The HCl molecule is considered. In HCl gas in its normal condition there seems to be no vibrational energy. Its molecules, however, may be in any rotational state. In the diagrams of one of the bands measured by Innes each line appears as a doublet. The interpretation is that the Cl atom is isotopic. The vibrational energy is a function of the masses of the vibrating atoms. The computed differences of the frequencies of the lines due to Cl atoms of atomic weights 35 and 37 agree with the differences between the observed lines within experimental error. As this method of detecting isotopes differs entirely from the positive ray method of Thomson and Aston it is highly desirable to develop it further. The absence of a line between + 1 and − 1 in all the bands of the halogen hydrides, and presumably also in the case of methane, is evidence in favour of the half-quantum number for indicating stationary rotational states. Further evidence is furnished by the results of applying strong electric fields to the absorbing gas. Barker, in his experimental work, finds no measurable shift of the line − 1. His results confirm, therefore, the use of half-quantum numbers. It cannot be said that the problem of the molecular structure of simple molecules has been solved in the sense that the problems of the H atom and ionised helium have been solved. The situation is more analogous to that of the heavier atoms, where the solutions were qualitative rather than quantitative. J. J. S.

2081. *Qualitative Studies of the Infra-red Absorption Spectra of Organic Compounds.* **J. Lecomte.** (Comptes Rendus, 178. pp. 1530–1532, May 5, 1924.)—A number of organic compounds have been studied and general rules drawn up with respect to the variations in behaviour of different types of structure, such as alcohols, ketones, and so on.

W. V. M.

2082. *Qualitative Studies of the Infra-red Absorption Spectra of Organic Bodies.* **J. Lecomte.** (Comptes Rendus, 178. pp. 1698–1701, May 19, 1924.)—Following previous results (see preceding Abstract) the phenomena attendant upon isomerism and effects appearing in homologous series have been examined. It is found that the influence of the form of the carbon chain is small. The classical dispersion theories do not fit the facts observed in the case of organic substances, but the quantum theory promises to throw light on the results. **Errata** (*ibid.* p. 1931, June 2, 1924). W. V. M.

2083. *Interference Bands Produced by Mica and the Use of Mica Windows in Infra-red Spectroscopy.* **C. F. Meyer and D. W. Bronk.** (Astrophys.

J. 59. pp. 252–258, May, 1924.)—Sheets of mica placed in a beam of infra-red radiation may introduce large variations in intensity in the spectrum, due to interference, as is shown by an illustrative graph. Other graphs show that the variation introduced by a single sheet of mica is regular, and amounts to about 10 % in the region of 3·5 μ. When mica is used for windows of absorption cells, the use of compensating windows cut from the same sheets of mica is in general not effective in compensating for the variations in intensity due to interference. If a sheet of mica 0·05 mm. thick is placed in the beam, with the normal to the sheet making an angle of 30° with the axis of the beam, then the variation in intensity is obliterated.

An Interference-free Cell.—A cell which eliminates interference effects by the foregoing method and embodies other unique features is described.
Authors.

2084. *A Photographic Method in the Ultra-red.* **A. Terenin.** (Zeits. f. Physik, 23. 5. pp. 294–297, 1924.)—The method employed by the author with Ilford Monarch plates is described under the following heads: The preparation of the plate (*i.e.* solution in which it is bathed before exposure); the preliminary lighting; the method of exposure of the plate to the ultra-red spectrum; the developing and fixing of the exposed plate. A. E. G.

2085. *Polarisation of Resonance Radiation of Vapours.* **P. Pringsheim.** (Zeits. f. Physik, 23. 5. pp. 324–332, 1924.)—If the observations of Wood and Ellett [see Abstract 1861 (1923)] on the polarisation of resonance radiations in a magnetic field can be explained as Zeeman effects, then, according to the Somerfeld-Lande interpretation, and taking into consideration the various abnormal Zeeman types for single lines, all the usual appearances can be completely explained. In the present paper it is shown that, whilst the quantitative difference of the maximum degree of polarisation with Na on the one side and Hg on the other can be explained by the different types of their abnormal Zeeman effect, the unequal field strength by which this polarisation is caused in both cases originates from the difference in the size of the disturbance which is produced through the local magnetic fields of the neighbouring molecules. Whether there is also a clear dependence on temperature as well as that on pressure can only be decided by spceial experiments. A. E. G.

2086. *Terms of the* (*C* + *H*) *Bands.* **A. Kratzer.** (Zeits. f. Physik, 23. 5. pp. 298–323, 1924.)—In this paper it is shown that the (C + H) band at λ4300 Å. seems to exhibit itself by the combination of four initial terms with an end term belonging to them. The end terms are shown quantitatively by the formula of Kramers and Pauli [see Abstract 1395 (1923)] for diatomic molecules. The impulse moment about the atomic combining line is given as $1.h/2\pi$. The initial terms can be shown through the same formula. Through the combination connection between the band 4300 and the η-band 3900 it is shown that both have the same end condition of molecules. The combination defects are explained by the existence of selection rules, which prevent a part of the possible combinations. The question as to the nature of the carriers of the bands, whether CH or CH_2, is left open. A. E. G.

2087. *Series Spectra of Boron* 111. **I. S. Bowen and R. A. Millikan.** (Nat. Acad. Sci., Proc. 10. pp. 199–203, May, 1924.)—The authors have produced evidence in a previous paper [Abstract 1466 (1924)] that in hot-spark spectra the strongest lines are usually those due to the stripped atom, *i.e.* the atom which has lost all its electrons and become similar to the hydrogen atom. If circular orbits are assumed, the wave-lengths to be expected can easily be calculated. This is sufficiently accurate for large orbits, where the electron at no part of its path comes close to the nucleus; but where the orbit is a flat ellipse better accuracy is obtained by dividing the corresponding values for lithium by nine. Several lines were found to be in the expected positions within about 1 part in 3000, and in addition the doublet separation of the line at 678 Å. was measured in orders up to the sixth and found to be 0·15 Å. Two other doublets were found having the same frequency difference, and these were identified as the first members of the sharp and principal series. A. C. M.

2088. *The Infra-red Absorption Spectrum of Carbon Monoxide.* **E. F. Lowry.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 647–658, May, 1924.)—A study of the infra-red absorption spectrum of CO was undertaken in order, if possible, to obtain more evidence for the application of quantum considerations to molecular behaviour. The spectrometer is described in some detail, and is of a special combination prism-grating type, the method and accuracy being tested by an examination of the known HCl absorption band at 3·46μ, the results being in good agreement with previous observers. For CO a doublet with maxima at 4·600(1)μ and 4·728(5)μ, with the centre of the band at 4·6643μ is obtained. There is little evidence of fine structure of the band. The moment of inertia of the CO molecule is calculated to be $14 \cdot 9 \times 10^{-40}$ gm.-cm.², the distance between atomic centres being $1 \cdot 15 \times 10^{-8}$ cm., agreeing very well with results due to Eucken [Abstract 1621 (1921)] and other workers.

W. V. M.

2089. *Laboratory Method of Obtaining Balmer Absorption Series of Hydrogen.* **E. O. Hulburt.** (Phys. Rev. 23. pp. 593–597, May, 1924.) —Condensed discharges were passed through an under-water spark in series with a tube, 75 cm. in length, of moist hydrogen at a pressure of 0·5 mm. of mercury. The light from the spark traversed the glowing hydrogen, and the Balmer lines appeared as narrow, dark absorption lines against the continuous spectrum of the spark, the absorption series extending to the tenth Balmer line. By adjusting the relative intensities of the light of the spark and of the glowing hydrogen, spectra were obtained with H_α and H_β either bright or dark, while the higher members of the series remained always dark. Spectra were produced showing H_β and H_γ dark, but with a bright central core. These phonomena are well known in stellar spectra, to which reference is made. AUTHOR.

2090. *The Spectrum of Ionised Lithium.* **M. Morand.** (Comptes Rendus, 178. pp. 1701–1704, May 19, 1924.)—Continuing previous work [Abstract 1876 (1924)] an arrangement whereby more light may be obtained is described, enabling feebler lines to be photographed. In this way very interesting results have been obtained. A table of observed wavelengths is given, and the origin of various lines discussed. Thus λ4678 appears to be the first term of a Bergmann series for once-ionised lithium, while the very feeble λ4501 appears to belong to doubly-ionised lithium, and corresponds to the spectrum of hydrogen, a factor 9R instead of R appearing on account of the greater nuclear charge for lithium. It is found that λ7600 (2S − 2P) corresponds to the first term of the principal series of ionised lithium. Another line, 2934, belongs to "otholithium" in an ionised state with abnormal coplanar electronic orbits, while 7600 belongs to a more stable state with inclined orbits.

Using Sommerfeld's relation between the constants $p, d, b \dots$ of an ionised atom and p^*, d^* of the arc spectrum of the preceding atom, the level 1S of lithium has an energy 64·7 volts and for 2s 19·9 volts. Now the difference 1S − 2s = 44·8 volts, representing the transition from para-ortholithium, is precisely equal to the minimum difference of potential through which a bombarding electron must fall in order to excite λ2934 [Abstract 1175 (1924)]. The lines λλ4678, 4664 may be the first terms of Bergmann series of para- and ortholithium, the constants b and d being different in the two cases. W. V. M.

2091. *Selective Absorption by Luminous Mercury Vapour.* **E. P. Metcalfe and B. Venkatesachar.** (Roy. Soc., Proc. 105. pp. 520–531, May, 1924.)—The absorption of the components of the 5461 Å. group $1p_1 - 1s$ by luminous mercury vapour is examined, using a Lummer-Gehrcke plate and an absorbing column 100 cm. long. All the satellites except − 0·237 Å. are found to be strongly absorbed under suitable conditions; − 0·237 Å. is absorbed, but to a much less degree. The ratio of emission to absorption is found to be fairly constant for all the lines, with the same exception. Again, all the resolved satellites, except − 0·237 Å., can be reversed on a continuous bright background. The conditions for reversal are discussed. The bearing of these results on the possible isotopic origin of some of the satellites is considered. The absorption and reversal of the lines 5769 Å., 1P − 2d', and 5791 Å., 1P − 2D, in both of which the absorption centres are atoms in the state 1P, are also observed. Two satellites of the former (0·044 Å. and − 0·050 Å.) have been reversed. The effectiveness of long columns as radiators of weak lines is brought out by the observation of the feeble satellite − 0·122 Å. of 5679 Å., in the light radiated from the end of a 100-cm. column carrying a current of 0·06 amp./sq. cm. Four satellites of $1p_2 - 1s$ have also been reversed. Further work is in progress. [See Abstract 680 (1923).] G. A. S.

2092. *Ultra-Violet Absorption Spectrum of Naphthalene Vapour.* **V. Henri and H. de László.** (Comptes Rendus, 178. pp. 1004–1006, March 17, 1924.)—The vapour of naphthalene examined with a thickness of 30 cm. at pressures varying between 0·054 mm. and 121 mm. exhibits an absorption spectrum composed of a very great number of bands. When the pressure does not exceed 0·22 mm. a series of eleven narrow bands is obtained having maxima at λ = 2784, 2778, 2750, 2740, 2710, 2680, 2644, 2613, 2590, and 2560 Å. These bands are perfectly continuous, presenting no fine structure. When the vapour tension is above 0·22 mm. a new series of bands is observed whose number increases with the pressure. They are situated between 2820 and 3200 Å. They are very narrow, and the authors have measured more than 400 of them. There are eighteen different series, of which the heads are on the ultra-violet side. These bands shade off towards the red. Each series is composed of about twenty very fine bands or rays distant from each other about

0·3 or 0·4 Å. and showing different intensities, often having the appearance of series of doublets very close together.

A study of the distribution of the narrow bands shows that they can be represented by the following formula: $1/\lambda = 32455 \cdot 4 + n \, . \, 474 \cdot 4 + p \, . \, 203 \cdot 4 + q : 62 \cdot 7 + R(m) + P(m) + Q(m)$, n having the values $-2, -1, 0, +1, +2$; $p = -4$ to $+4$, and $q = -7$ to $+2$. This formula contains three fundamental frequencies: $\alpha = 744 \cdot 4$, $\beta = 203 \cdot 4$, and $\gamma = 62 \cdot 7$ (cm.)$^{-1}$, which correspond to the frequencies of vibration of the different groups of atoms which form the molecule of naphthalene. It is interesting to note that the frequency $\alpha = 474 \cdot 4$ is about two times smaller than the corresponding frequency in benzene and its derivatives. For benzene $\alpha = 921 \cdot 4$, for toluene $\alpha = 932 \cdot 5$, and for chloride of benzene $\alpha = 963 \cdot 7$.

It is deduced that the moment of inertia of the normal molecule $I_0 = 3 \cdot 55 \, . \, 10^{-40}$ and that of the activated molecule $I_1 = 5 \cdot 5 \, . \, 10^{-40}$. The moment of inertia of the molecule of naphthalene thus changes greatly during activation by rays comprised between 3200 and 2820 Å., consequently the configuration of the atoms in this molecule changes much during activation. The potential of ionisation is about 10 volts. The internal transformation of the molecule, which appears sharply at a well-determined limit, to which corresponds a quick change in the spectrum of absorption, is a general phenomenon found by one of the authors for a whole series of the most different bodies. The value of the moment of inertia of the molecule of naphthalene obtained by the study of the spectrum of the vapour is very small. This means that the carbon atoms are very close together in the molecule; their distance apart is much inferior to that of the carbon atoms in crystals of diamond and graphite (1·54 and 1·46 Å.). This result is in agreement with the representation according to which the bond between the atoms in a molecule is produced by valency electrons which have symmetrical orbits enclosing the two atoms. The sphere which envelopes the orbits of the four valency electrons of carbon has a diameter of 1·32 Å., while the diameter of the orbit of the two internal electrons is 0·18 Å. Thus, the distance between the carbons in a molecule may be between 1·32 and 0·18 Å. According to the special model adopted for the molecule of naphthalene it is possible, starting from the value of the moment of inertia, to calculate the distances between the atoms of carbon in that molecule. J. J. S.

2093. *Light Emitted from Solid Nitrogen when Bombarded with Cathode Rays, and its Bearing on the Auroral Spectrum.* **L. Vegard.** (K. Akad. Amsterdam, Proc. 27. 1–2. pp. 113–126, 1924. Comptes Rendus, 178. pp. 1153–1156, March 31, 1924.)—Investigations recently carried out on the auroral spectrum led the author to the view that the upper strata of the atmosphere above 90 km. were mainly composed of nitrogen, frozen into minute dust particles. These particles were supposed to be more or less electrically charged through the photoelectric effect of the sun's rays, and in this way gravity was counterbalanced. If this hypothesis is correct the auroral spectrum should originate from nitrogen, and should be a type of spectrum produced when solid nitrogen is bombarded with electric rays. Above all, the green line ($\lambda = 5577$) should be peculiar to solid nitrogen.

Experiments, full details of which are given, have been carried out at Leiden, in which solid nitrogen was bombarded with cathode rays.

A layer of solid was easily formed under the experimental conditions described, and at first cathode rays with a potential drop of 75 volts were put on, and the nitrogen emitted a faint luminosity, but when the voltage was increased to 200 volts a line in the green (5230 Å.) was seen. At 500 volts the nitrogen showed two strong green lines near the blue part (called N_2), and another very near the yellow part (called N_1). N_1 consists of several lines. The relative intensities of N_1 and N_2 depend enormously on the cathode-ray velocities. Thus, at 350 volts N_1 disappears, and only the line N_2 is seen, but at 700–750 volts it is predominating. The layer of solid nitrogen remained luminous and showed the same green colour when the discharge was broken and the cathode rays cut off, and even after five minutes the layer of solid nitrogen was still distinctly seen to emit green light. The mean of spectroscopic and spectrographic values obtained for N_2 is 5230, and it is excited at a tension somewhat under 200 volts, while its intensity relative to that of the negative band increases to a maximum at about 400 volts. N_1 is excited at 400 volts, and its intensity increases very rapidly.

A comparison with the auroral spectrum shows that the strong auroral line lies in the group N_1, while N_2 is found to have a position corresponding to a conspicuous line emitted during intense auroral displays, and hence we may conclude "that the conspicuous green auroral spectrum is due to the peculiar light effect produced in solid nitrogen." Thus in both cases the spectra are dominated by the negative band heads 4708, 4278, and 3914, and both in the auroral spectrum and in the spectrum of solid nitrogen the three strongest bands are followed by a second head with a somewhat smaller wave-length, while the relative intensities seem to be the same in both cases. Again, 4058, 3998, 3805, 3756 appear in the two spectra with the same relative intensities, while the slow fading away of the light after an auroral display corresponds to the phenomena observed in solid nitrogen, and it must be concluded that the typical auroral spectrum is emitted from that element in its solid state. This fact must be taken into account with respect to theories of the blue of the sky, the zodiacal light, the twinkling of stars, the colour variation of auroral, and the reflection in the upper strata of the atmosphere of electric and acoustic waves. Again, if other elements can be brought to emit line spectra when exposed to radiations, new possibilities are given for understanding the state of the stellar nebulæ and the origin of nebular lines, while by an accurate comparison of the auroral spectrum and that observed in solid nitrogen information may be obtained with respect to the bombarding rays in auroral displays, particularly concerning their velocities and the temperature of the dust particles of the auroral region. The physical aspects of the results are also interesting with reference to band and other spectra. Spectrographs of the spectra obtained under various conditions are given as well as photographs of auroral spectra for comparison. W. V. M.

2094. *Arc Spectrum of Phosphorus.* **M. O. Saltmarsh.** (Phil. Mag. 47. pp. 874–882, May, 1924.)—With the exception of possible lines in the infra-red, the arc spectrum of phosphorus lies completely in the ultra-violet, beginning at λ2555. The spectrum was produced in two ways, (1) by feeding phosphorus pentoxide into a carbon or a copper arc, and (2) by passing a discharge from an induction coil through a Geissler tube containing yellow phosphorus and hydrogen at low pressure. Three quartz spectrographs and a Hilger vacuum grating spectrograph were used. The arc spectrum consists of 35 lines from 2550 to 1672, of which only four have been previously recorded. Those longer than 1864 were produced in two ways, and those of shorter wave-length by the discharge tube only. A group of five close lines from 2154 to 2136 agrees in wave-length with that calculated from the radiation potential. The frequencies of all the lines are connected by systems of constant frequency differences, and thus the arc spectrum of phosphorus probably obeys the Sommerfeld-Kossel Displacement Law. The frequencies of fifteen of the strongest lines can be expressed by means of nine terms, and some of these lines can be arranged as multi-doublets. F. S.

2095. *Analysis of the Arc Spectrum of Titanium.* **C. C. Kiess** and **H. K. Kiess.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 607–645, May, 1924.)—A brief account is given of the evidence for the "displacement law" that series regularities of even and odd structure alternate across the periodic table. Observations have been made on the arc spectrum of titanium from 2100 Å. to 9700 Å., the spectrograms up to 2900 Å. being made on a large type E Hilger quartz spectrograph. The multiplets presented in the table belong either to a triplet series system, or to the quintet systems, or to combinations between the two systems. All the lines classified belong to King's [Abstract 1415 (1914)] temperature Classes I, II and III. Approximately 400 lines of the arc spectrum of titanium have been classified in both triplet and quintet systems, the lowest level being an *f* level, that is, a level for which the azimuthal quantum number is 4. An energy diagram is given.

The prominent low-temperature lines of the spectrum which King has assigned to Class I are all, with one exception, members of *ff* and *fg* multiplets of the triplet system. In structure the multiplets of titanium follow closely the selection principles for azimuthal and inner quantum numbers and the intensity rule. All the classified lines result from combinations between terms whose azimuthal quantum numbers *k* differ by 1 or 0.

The atomic number of titanium is 22. Bohr's arrangement of the electrons in the normal state of the atom places two in the 1_1 orbit, four each in the 2_1, 2_2, 3_1 and 3_2 orbits, and two each in the 3_3 and 4_1 orbits. For an electron to occupy a 4_4 orbit the atom, according to this arrangement, would have to be in an excited state. The series converging to 4_4 orbit would be *f* series, analogous to those occuring in the spectra of the alkalies and the alkaline earths, and would resemble in structure the corresponding series of hydrogen. That such, however, is not the case for titanium is clearly demonstrated by the series regularities presented by the authors. In the normal state of the atom the series electrons occupy the 4_4 orbits, and the series converging to these orbits are decidedly unlike the hydrogen series. W. V. M.

2096. *The Apparent Selective Reflection of X-Rays by Crystals.* **W. Kossel.** (Zeits. f. Physik, 23. 5. pp. 278–285, 1924.)—The author discusses the phenomena observed by G. Mie [Abstract 280 (1924)] and by G. L. Clark and W. Duane [Abstract 2202 (1923)], and ascribed by the latter to selective reflection. If this is correct, the existing theory of radiation requires alteration, and specially so to explain the abnormal intensity relation between the lines (K_β stronger than K_α). The author shows, however, by a simple numerical consideration of Duane's curves, that at least the greater part of the phenomena depends on known processes; for the present there seems to be no reason to make any change in the existing theory. The intensity differences shown in Duane's curves for CsI_3 can be explained by the fact that, as soon as the wave-lengths fall outside the heads of the absorption bands of the crystal materials Cs and I, the waves suddenly penetrate far deeper, and with greater intensity, into the crystal, and hence are scattered with greater intensity. The actual intensity ratio, at the first sudden rise, agrees numerically with that to be expected theoretically from the absorption coefficients in the case of CsI_3, and also for reflection at the 100 planes of KI; for reflection at the 100 planes the intensity ratio, however, is three times as great as is to be expected from the absorption coefficient ratio, and a repetition of the measurements seems desirable. The original paper should be consulted in connection with the formation of the K lines in Duane's curves and for suggestions as to further investigation of the subject. It may be noted that B. Walters has not observed this line production photographically by the rotating crystal method. H. N. A.

2097. *Absorption Measurements of Certain Changes in the Average Wave-Length of Tertiary X-rays.* **S. K. Allison and W. Duane.** (Nat. Acad. Sci., Proc. 10. pp. 196–199, May, 1924.)—In a series of experiments by Clark and Duane [Abstracts 869 and 1491 (1924)] on the wave-lengths of secondary X-rays the radiation from the secondary radiators has been found to contain tertiary radiation with a high-frequency limit ν, given by the equation $\nu = \nu_1 - \nu_2$, where ν_1 is the frequency of the primary radiation and ν_2 a critical absorption-frequency of the secondary radiator. Experiments on the secondary X-ray spectrum at different angles from the primary beam showed that, while the short wave-length limit of the tertiary radiation remained fixed, the maximum of the " hump " shifted towards longer wave-lengths with increasing angle.

The authors now examine the shift of the maximum of the tertiary radiation by a method described by Ross (Phys. Rev. 22. p. 524, 1923), the tertiary radiation of silver (0·366 Å.) being studied, using absorption screens of iodine (K, 0·3737 Å.), tellurium (K, 0·3896 Å.) and antimony (K, 0·4065 Å.), the wave-length shifts being 0·164 Å., 0·180 Å. and 0·196 Å. respectively. It appears also that in scattering from elements as heavy as silver, the shape of the tertiary hump depends to a considerable extent on the filtration. The results are shown to disagree markedly from the theory of A. H. Compton [Abstract 2194 (1923)]. A. B. W.

2098. *Corpuscular Theory of the Distribution of the Recoil Electrons Produced by Polarised X-Rays.* **G. E. M. Jauncey.** (Phys. Rev. 23. pp. 580–582, May, 1924.)—In a previous paper [see Abstract 535 (1924)] a formula for the number of X-ray corpuscles scattered in a direction ϕ and crossing 1 sq. cm. of a sphere of large radius R has been obtained for the case of the scattering of polarised X-rays. For every X-ray corpuscle scattered in this direction an electron recoils in the direction ψ, where $(1 + a) \tan \psi = \cot \phi/2$ and $a = h/mc\lambda_0$, and the number of electrons recoiling in the direction ψ and crossing 1 sq. cm. of the sphere can therefore be calculated. A formula for the angular distribution of the recoil electrons is given for any direction of polarisation. This formula is applicable to Wilson photographs of recoil electrons. AUTHOR.

2099. *Photographic Blackening-Law for X-Rays.* **E. Jönsson.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 18. No. 14. pp. 18–23, 1924. In German.)—The author examines experimentally the relation between blackening and time of exposure of a photographic plate under the action of homogeneous X-rays. The method is applied to the photometry of spectrum plates. A. B. W.

2100. *Scattering of X-Rays.* **I. Malzlish.** (Frank. Inst., J. 197. pp. 667–690, May, 1924.)—This paper presents a discussion of the possibility of modifying the classical theory of scattering (that of J. J. Thomson) so as to account for the decrease in the scattering coefficient as well as the asymmetry in the scattering. By assuming that the electron is made up of a number of parts—for simplicity, of two parts—it has been found possible to account for the diminution of the scattering coefficient without at the same time explaining the observed asymmetry. To accomplish both objects, the author combines this theory with that of Debye, who assumes that all the electrons in an atom are arranged in a single ring, and that they are spaced at equal intervals. A. B. W.

2101. *Tertiary Line Spectra in X-Rays.* **D. L. Webster.** (Nat. Acad. Sci., Proc. 10. pp. 186–191, May, 1924.)—In recent papers Clark and Duane [Abstracts 869 and 1491 (1924)] report the discovery of unexpected peaks in the ionisation spectra of secondary X-rays. The author now raises theoretical objections to the explanation given by Clark and Duane that these peaks are due to tertiary radiation, and shows that they must be due to some other cause. It is now proposed, as a possibility, that the tertiary radiation arises from the impact of a photo-electron against a secondary electron in the same atom from which it came. Experiments are suggested to test the theoretical points raised. A. B. W.

2102. *Theory of the Tertiary Radiation Produced by Impacts of Photo-Electrons.* **G. L. Clark and W. Duane.** (Nat. Acad. Sci., Proc. 10. pp. 191–196, May, 1924.)—The authors have recently published accounts of experiments [Abstracts 1492 and 1810 (1924)] in which tertiary radiation due to the impacts of photo-electrons produced by primary X-rays has been discovered. Reference is now made to Webster's proposed modified theory [see preceding Abstract], the origin of this "tertiary" radiation, and experimental tests are applied to discover which theory is the more correct. It is concluded that the author's theory fits the facts more satisfactorily than the modified theory proposed by Webster. A. B. W.

2103. *Some Observations on Hugo Stintzing's Paper on "Röntgenographic-chemical Investigations."* **M. Siegbahn.** (Zeits. phys. Chem. 109. 5–6. pp. 431–434, 1924.)—This paper deals with Stintzing's recent publication [see Abstract 915 (1923)] on the use of Röntgen-spectroscopic methods for chemical purposes, and to his criticism of the accidental character of Siegbahn's work. Stintzing's apparatus is therefore discussed at length, and not only its out-of-dateness pointed out, but the vital condition of sufficient evacuation emphasised when the function of the Röntgen tube follows well-known rules. From Stintzing's description of his method, and the negative character of his results, the author concludes that this and other precautions have not been properly observed. These experimental mistakes are shown to be avoided in the improved form of apparatus used by the author. H. H. Ho.

2104. *The Nature of the Relativity Röntgen Doublets.* **A. Landé.** (Zeits. f. Physik, 24. 2. pp. 88–97, 1924.)—A previous paper [see Abstract 2433 (1923)] has dealt with Röntgen spectra by means of a model in contrast to the relativity method of Sommerfeld in 1916, and is based upon the analogy first noticed by Grotrian between the Röntgen term-structure and the optical doublet terms. A series of experimental facts are now discussed which are incompatible with the relativity conception of the Röntgen doublets, and support instead an interpretation analogous to the optical alkali doublets. The question as to why both kinds of doublets fit in with relativity interval formulæ is regarded as a fundamental difficulty for the quantum theory of atomic structure. An after-note deals with the incompleteness of the Bohr theory of spectra as responsible for the incompatibility of the relativity and optical standpoints for the nature of the Röntgen doublets. H. H. Ho.

2105. *Soft X-Rays from the Heavy Elements, Tantalum, Tungsten, Osmium, Iridium, Platinum and Gold.* **J. C. Boyce.** (Phys. Rev. 23. pp. 575–579, May, 1924.)—Soft X-radiations excited by electron bombardment at voltages between 30 and 1500 volts were studied by the use of Kurth's apparatus, in which the photoelectric effect of the radiation per unit electron current is measured. In this range for each metal from 6 to 9 critical voltages were located to within about 5 per cent. The results are in fair agreement with the values Bohr and Coster predicted for the ionization potentials of the N-level electron orbits, by means of the combination principle, from the X-ray wave-lengths measured by Siegbahn and others. The limitations of the method are considered and also the extent to which agreement is to be expected between the two different methods of measuring the energies of these levels. AUTHOR.

2106. *Intensities in X-Ray Spectra.* **A. Dauvillier.** (Comptes Rendus, 178. pp. 1522–1524, May 5, 1924.)—It is important to obtain values of the ratios α_1/α_2, β_1/β_2, $(\beta_1 + \beta_2)/\gamma$, etc., in order to check calculations of the probability of transfer from one orbit to another. The method used was to pass the rays through layers of aluminium, and to compare the thicknesses which for two different λ's produced the same amount of absorption. The rays investigated were the K-series of molybdenum and silver and the L-series of gold and uranium. For the K-series, the ratio α_1/α_2 was the same as β_1/β_2, namely, two. The values of $(\alpha_1 + \alpha_2)/\gamma$ and $(\beta_1 + \beta_2)/\gamma$ were about five. This leads to the conclusion that the initial levels for the K-series contain four and two electrons respectively. The results for the L-series are based on observations of eight gold rays and ten of uranium. The ratio of the L_3 components is not much less than two. The ratios of the terms β_1, γ_1, and γ_2 were about five, while the quotient of the components α_1, α_2 of the other term is nearly seven.

A. C. M.

2107. *X-Ray Absorption Spectra of Potassium and Calcium.* **A. E. Lindh.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 18. No. 14. pp. 12–17, 1924. In German.)—The results of this investigation are indicated in the following table, the critical absorption wave-lengths, using the cobalt $K\alpha_1$ line), having been determined for potassium and calcium in the form of element, and combined chemically :—

	λ.	ν/R.	ΔV (in Volts).
K	3431·0	265·59	—
KCN	3429·3	0·73	1·8
KCNS	3428·7	0·77	2·4
KI	3428·3	0·80	2·8
KCl	3428·0	0·82	3·1
$K_2S_2O_8$	3427·3	0·86	3·9
K_2SO_4	3426·7	0·93	4·5
$KClO_4$	3426·3	0·95	4·9
Ca	3064·3	297·38	—
$CaCO_3$	3060·5	0·74	5·0

A. B. W.

2108. *X-Ray L-Absorption Spectrum of Iodine.* **J. G. Tandberg.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 18. No. 14. pp. 1–2, 1924. In German.)—Gives an account of a series of measurements of the L-absorption frequencies L_1, L_2 and L_3 of iodine in the form of element, NaI, $NaIO_3$ and $NaIO_4$. The results are included in the following table :—

	Substance.	λ.	ν/R.	Δλ.	Δν/R.	ΔV.
L_1	I	2711	336·1	0	0	0
	NaI	2708	336·5	− 3	0·4	5
	$NaIO_3$	2709	336·4	− 2	0·3	4
	$NaIO_4$	2703	337·1	− 8	1·0	13
L_2	I	2548	357·6	0	0	0
	NaI	2542	358·4	− 6	0·8	12
	$NaIO_3$	2544	358·3	− 5	0·7	9
	$NaIO_4$	2541	358·6	− 7	1·0	14
L_3	I	2402	379·2	0	0	0
	NaI	2397	380·2	− 5	0·8	11
	$NaIO_3$	2398	380·1	− 4	0·7	9
	$NaIO_4$	2397	380·2	− 5	0·8	11

In the table R is Rydberg's constant 109·737 cm.$^{-1}$ and $\nu = 1/\lambda$; for Einstein's formula $\varepsilon V = h\nu$ is determined the voltage difference ΔV between iodine free and combined. The table indicates that the L-absorption relations are not so simple as the K-absorption series for iodine.

A. B. W.

2109. *Structure of the $K\beta_1$ Line of Sulphur.* **A. E. Lindh** and **O. Lundquist.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 18. No. 14. pp. 8–11, 1924. In German.)—Hjalmar has shown [Abstract 914 (1922)] that the $K\beta_1$ line of sulphur is not simple, but a satellite on the short wave-length side. Using a Siegbahn precision spectograph, exact measurements are now made of this "line" when the element rhombic sulphur is used with anticathodes of Cu, Zn and Fe; the sulphides of Cu, Sn, Ag, P, Cr, Zn, Pb, Cd, and Fe with copper anticathode; and the sulphates of Zn, Su, Fe, Pb, Ag, and Cd with copper anticathode. The results are very surprising. Taking the pure element, the doublet appears with the copper anticathode, but not with zinc or iron anticathodes. Similarly, the doublet appears with the sulphides of Cu, Sn, Ag and P, using a copper anticathode, but not with the sulphides of Cr, Zn, Pb, Cd and Fe. The doublet appears with all the sulphates with the exception of cadmium. A. B. W.

2110. *Development of the Rotating Crystal Method of X-Ray and Crystal Analysis.* **M. Polányi, E. Schiebold** and **K. Weissenberg.** (Zeits. f. Physik, 23. 6. pp. 337–340, 1924.)—A brief note referring to the history of the method. The original should be consulted. A. B. W.

2111. *X-Ray Investigations with Amalgams.* **G. v. Simson.** (Zeits. phys. Chem. 109. 3–4. pp. 183–198, 1924.)—Using the powder method of X-ray analysis due to Debye and Scherrer, the author examines the structure of amalgams of zinc, tin, cadmium and lead. The paper includes reproductions of X-ray spectra of the amalgams containing varying percentages of these elements. A. B. W.

2112. *Precision Apparatus for X-Ray Measurement.* **S. K. Allison** and **G. L. Clark.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 681–691, May, 1924.)—A detailed description is given of the X-ray research installation at the Jefferson Physical Laboratory, Harvard (Professor W. Duane), with a comprehensive list of references in conclusion. Details are given for using two X-ray tubes in parallel with the same transformer. Ionisation chambers have been standardised and built of pyrex glass. Improved variable resistances for accurate adjustment in the filament heating circuits of Coolidge tubes have been devised. A. B. W.

RADIO-ACTIVITY.

2113. *Acoustic Observation and Galvanometric Registration of Elementary Rays and Single Ions.* **H. Greinacher.** (Zeits. f. Physik, 23. 6. pp. 361–378, 1924.)—Two methods are described, in which sounds are produced in a telephone by individual corpuscles; both make use of the Geiger counter. In the first the pointed rod of the counter was connected to the grid of a triode valve, and the telephone with a 20-volt battery in series was placed in the anode circuit; the cylinder of the counter was connected to the + pole of a rectifier, which gave a voltage of about 1500 volts. In the second method the rectifier was replaced by an electron tube, combined with a condenser, the same battery being used to heat the cathode of this tube and those of the amplifying valves. The cylinder of the Geiger counter is in this case connected to the grid of the triode valve, which actuates the telephone. This somewhat alters the working of the valve, as each discharge causes a diminution of the anode current, while, in the case of the first method, a discharge causes an increase in the anode current. The theory of the two methods is discussed, and it is shown that in the second it is essential to provide a high-resistance leak, connecting the grid to the cathode, as otherwise the dynamic negative rest potential of the grid will rise so high, with rapidly repeated discharges, that no sound will be produced in the telephone. When a polonium preparation was brought near to the counter noises began at irregular intervals when the distance was equal to the range of the α-particles; further diminution of the distance produced a rattling noise, which finally became a hissing with no definite pitch. The mean value obtained for the range, using the first method, was 3·85 cm. at 15° C. and 760 mm., which agrees with the latest values obtained by other methods. It is possible to use the method for demonstrating the phenomena to an audience, and several suitable experiments are described. Photoelectric electrons can be made audible by illuminating the point of the counter with an arc lamp, and the effect of ions formed outside the counter was found to be considerable in the case of Method II. The paper also describes how the elementary rays can be registered photographically by means of a galvanometer; and several records are reproduced, which show that it is possible to distinguish between the records of α- and β-particles, the momentary deflections being much larger for the former than for the latter. H. N. A.

2114. *The Law of Probability Applied to the Radio-Active Radiation of Polonium.* **W. Kutzner.** (Zeits. f. Physik, 21. 5. pp. 281–298, 1924.)—The α-radiation of polonium does not always obey Bateman's probability formula for a phenomenon of a purely fortuitous character. A photographic method of registering the emission of individual α-particles was employed, using a string galvanometer actuated by a Geiger chamber, into which the individual particles passed and excited a momentary brush discharge from a point kept at a high potential. Equal time intervals were marked on the photographic ribbon, and for each interval the number of galvanometer deviations, *i.e.* the number of α-particles, was counted. It was found that the time intervals in which the number of particles was near the mean value were more frequent, and those in which the number was far from the mean value less frequent, than was to be expected from the laws of probability; in other words, the "cocked-hat" curve was distorted, rising to a higher, narrower point at the middle portion. This subnormal dispersion was greater the greater the activity of the preparation per square millimetre, and as the preparation grew weaker with the lapse of time the agreement between experiment and the probability law improved. The phenomenon is not altogether due to scattering, the oxidation of the surfaces and diffusion of polonium into the metal on which it is deposited, though all these causes affect it; it is assumed that the single radio-active polonium atoms mutually influence one another, so that the disintegration of one may accelerate that of a neighbour, or that the single α-particles act on some of the polonium atoms with which they collide, shattering them in the same way as they do certain of the lighter elements. The times between the ejection of successive α-particles do not follow the ordinary probability law; short time intervals are more frequent and long intervals less frequent than this law would indicate. H. N. A.

2115. *Separation of Polonium from a Sodium Hydrate Solution by Various Solids.* **J. Escher-Desrivières.** (Comptes Rendus, 178. pp. 1713–1715, May 19, 1924.)—The separation of a dissolved radio-active substance by a solid phase in the solution depends on the composition of the liquid phase. This has been studied for polonium in sodium hydrate, using solid bismuth hydrate [see Abstract 2443 (1923)]. The author now employs as separating solids ferric hydrate and animal charcoal. The specimens of animal charcoal employed were purified by boiling in HCl. The adsorbing power varied considerably in the experiments according to the length of this treatment; this may be due to carbonate and phosphate of calcium in the animal black. The separation of the polonium depends on the number of molecules of sodium hydrate per cc. of the solution, and the curves show that there is a marked discontinuity for a certain concentration with the three solids employed—bismuth hydrate, ferric hydrate and animal black. If n is the number of tenths of a cc. of 7-normal sodium hydrate in 3 cc. of the solution, X the ratio of the quantity of polonium dissolved to the quantity separated, m the mass of the solid, the graphs obtained can be empirically represented by the equation $X = ae^{\alpha n}m^k$ where a depends on the nature of the solid, and a and k are constants; α has two different values, α_0 for $n < 9$ and $\alpha' = 0{\cdot}4\alpha$ for $n > 9$. This discontinuity may correspond to a change in the nature of the ion or of the complex in which the polonium is engaged. In a feebly alkaline solution (decinormal) polonium is removed entirely by traces of solids or is deposited rapidly on the walls of the containing vessel. In a concentrated solution the polonium remains dissolved. It is probable that in feebly alkaline solutions the polonium is fixed to colloidal aggregates contained in the solution. H. N. A.

2116. *The Relation Between Uranium and Radium. Part VIII. The Period of Ionium and the Ionium-Thorium Ratio in Colorado Carnotite and Joachimsthal Pitchblende.* **F. Soddy and A. F. R. Hitchins.** (Phil. Mag. 47. pp. 1148–1158, June, 1924.)—The period of ionium has been redetermined from the rate of growth of radium in the uranium preparations purified from fifteen to eighteen years ago; in 1919 the rate of growth of Ra was found to be proceeding with the square of the time, with 237,500,000 years as the product of the periods of average life of Io and Ra, which gave 100,000 years for Io. In the new determination the average life of Io, $1/\lambda_2$ is calculated from the formula

$$1/\lambda_2 = \tfrac{1}{2}(U/Ra)(3{\cdot}4 \times 10^{-7}/2375)T^2,$$

where Ra grammes of radium are produced from U grams of uranium in T years. The value finally adopted is $1{\cdot}1 \times 10^5$ years. Expressions are worked out which allow the quantity of ionium in an ionium-thorium mixture to be found by determining the rate of growth of radium in it by emanation measurements; using these expressions, it is not necessary to wait for transient equilibrium. Experiments with American carnotite gave the ratio Io : Th = 23; calculating from the amount of thorium the γ-radiation due to mesothorium in this mineral, it was found that as much as 3 parts per 2000 of the γ-radiation of carnotite radium may, as a maximum, be due to thorium products, which is below the error of γ-ray measurements. Two specimens of ionium-thorium, separated from different products obtained in working up Joachimsthal pitchblende, gave the ratio Io : Th = 1 : 0·9. For the

ionium-thorium prepared from St. Joachimsthal material by Haitinger and Ulrich and A. v. Welsbach in 1908–1910, the atomic weight 231·51 has been found, and the ionium-thorium ratio 3 : 7 has been deduced. Meyer and Ulrich have found in one preparation from the same source nearly equal quantities of ionium and thorium, and although these investigators find variations in different specimens of Joachimsthal pitchblende, which they discuss in connection with the supposed parent of thorium, the authors consider that the divergence in the case of the preparation of Haitinger and Ulrich was due to its having been worked up in a thorium factory and contaminated by dust containing thorium.
H. N. A.

2117. *Motion of Radio-Active Ions in the Bunsen Flame.* **E. N. da C. Andrade.** (Zeits. f. Physik, 22. 5. pp. 345–346, 1924.)—Remarks on the work of H. Schönborn on this subject [see Abstract 1099 (1921)]. Schönborn found that positively charged carriers in a Bunsen flame attain velocities of 300 cm. sec./volt. cm. as compared with velocities of 2·5 cm. sec./volt.cm. previously found by the author [Abstract 1567 (1912)]. Schönborn states that such high velocities, 300 cm./sec., cannot be explained as due to the temperature of the flame.

The author also refers to H. A. Wilson's remarks [see Abstract 99 (1916)], in which Andrade's value is criticised as being *too high* (comparison being made with Wilson's value, 1 cm./sec. per volt/cm.). The author now gives further support to the views previously expressed, and criticises Schönborn's results.
A. B. W.

2118. *The Geiger α-Particle Counter.* **W. Kutzner.** (Zeits. f. Physik, 23. 1–2. pp. 117–128, 1924.)—The object of the paper was to discover the paths which beams of α-rays must traverse in the chamber if the α-particles are to be counted with certainty by means of the above apparatus. The electrical arrangements were those employed by the author in a previous paper [see Abstract 2114 (1924)], and the α-rays from a polonium preparation were sent through a narrow hole in a brass screen into the chamber, in numerous different directions, through a thin sheet of aluminium which closed a slit in the hemispherical end of the cylindrical chamber. It was found that, to be able to get a record of all the α-particles entering the chamber, it was necessary that the beam should pass through the aluminium foil inside a small surface of about 3 mm. diameter, the centre of which coincided with the prolongation of the axis of the pointed platinum wire, from which the brush discharges took place. The angle between the direction of the α-ray beam and this axis was not important as long as it was not so great that the thickness of aluminium traversed by the α-particles was sufficient to cause absorbtion. The records of the counter were compared with actual counts with a zinc sulphide screen, and the agreement was fairly good, the counter giving about 5 per cent. more particles than the screen. When voltage is switched on to the counter discharges take place, and on the inner wall a layer is formed which can retain a strong negative charge; this charge hinders further discharge. If an α- or β-particle passes through this layer its ionising action removes or diminishes the negative charge of the layer, and a new point discharge takes place; experiments are described which confirm this view. H. N. A.

2119. *The Radio-activity of the Rocks.* **J. Joly.** (Chem. Soc., J. 125. pp. 897–907, April, 1924.)—Although the acid rocks contain more uranium and thorium than the basic rocks, the ratio between the amounts of these two substances does not vary much from 1 : 2. This ratio must have been changing throughout geological time, and must continue to change, since the rate of decay of uranium is nearly three times that of thorium. It is suggested that all rock families originated in a world-magma by processes of differentiation which do not select between uranium and thorium. Lord Rayleigh has concluded that the first-formed silicate in rocks—zircon—is exceptionally rich in radium; it is suggested that this is due to the fact that zirconium oxide is isomorphous with the oxides of uranium and thorium, which may have caused the accretion by zircon of the radio-active elements from the magma. The intense ionisation round the zircon may be supposed to be favourable to the crystalline growth of molecules round it, and the growth of mica or hornblende round zircons may originate in this way. The haloes produced by radio-active action are described, including the effects of reversal and the relation between the halo, the age of the rock, and the amount of radio-active material in the central nucleus. The author has found haloes in the micas of Ytterby, of mid-Archæan age (pre-Huronian), which cannot be reconciled with those from known radio-active elements. There appear to be two varieties, X_1- and X_2-haloes. The nearest haloes to these are those of thorium, but the differences are such that it is not possible to ascribe them to this substance. These X-haloes may be regarded as evidence of an unknown element, which has vanished from the earth, or of an undiscovered radio-active element. In the same Ytterby mica, in rare instances, haloes of minute dimensions, and all completely bleached or reversed, are found; they are known as hibernium haloes. If the conversion factor in this mica be roughly taken as 2000, the range, in air, of the rays responsible for the smaller hibernium halo would be little more than 1 cm. These haloes may possibly be generated by one of the known elements, for they must, as shown by their minute trajectory, originate from an element so feebly radio-active that no known method would detect its radio-activity. H. N. A.

2120. *The Radio-active Constant of Radon.* **Irène Curie and C. Chamié.** (Comptes Rendus, 178. pp. 1808–1810, May 26, 1924.)—This constant was determined by Madame Curie in 1910, and by Rutherford in 1913, both obtaining T = 3·85 days for the period of radon; in 1921 Bothe and Leechner found T = 3·810 days. Suppose two similar bulbs are used, containing exactly equal quantities of radon in equilibrium with the quickly evolved active deposit, and that one of them is placed in an ionisation chamber, the moment t when the current i passes through a given value a being noted; if the two bulbs are placed together in the chamber, when the quantity of radon has been reduced to one-half, the same ionisation current a will be produced at time t' and $t' - t = T$, the half-life period. In practice it is not possible to obtain two bulbs with exactly equal quantities of radon, and the authors work out a formula for the case where the quantities are not simultaneously equal. Suppose the first bulb contains more than the second; determine the time t_1 when i_1, the ionisation current produced by this bulb, is a; take out bulb 1 and replace by bulb 2; let t_2 be the time when the ionisation current i_2 is a; place both together in the chamber, and determine t' the time when the current $i' = a$; then if t_1 and t_2 are nearly equal (nearly equal radon bulbs), $T = t' - \frac{1}{2}(t_1 + t_2)$. In practice two ionisation chambers were employed;

in the first the bulb was placed at the end of a metal tube and acted through about 12 mm. of lead; the current was balanced against the constant current a produced in the second chamber by a bulb of radium. Four experiments have been made, the results agreeing to within 1 in 1000. The final value is $T = 3{\cdot}823$ days, correct at least to 1 in 2000, and probably closer than this. **H. N. A.**

2121. *Secondary β-Rays Produced by X-Rays in a Gas.* **P. Auger.** (Comptes Rendus, 178. pp. 1535–1536, May 5, 1924.)—In a previous paper [Abstract 1503 (1924)] the author has suggested how the study of secondary β-rays, by C. T. R. Wilson's method, may give certain information relative to radiation quanta and the absorption of β-rays by matter. Reference is now made to a statistical analysis of experimental results. It is shown that the secondary β-rays have a tendency to travel in a "privileged" direction given by the relation $\cos\theta_m = \sqrt{\frac{a}{a+2}}$ $\left(\text{where } a = \frac{h\nu}{mc^2}\right)$ at the instant of their creation. **A. B. W.**

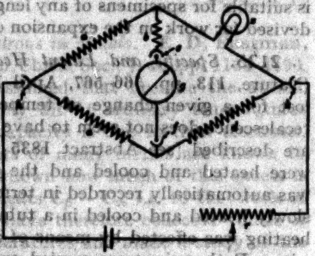
2122. *High-Frequency γ-rays from Radium.* **J. Thibaud.** (Comptes Rendus, 178. pp. 1706–1709, May 19, 1924.)—The method of de Broglie, with certain improvements, has been used to register photographically the secondary, high-velocity β-rays from a secondary radiator of thick lead surrounding a preparation of radium bromide. Lines indicating β-rays with the following energies in kilovolts were obtained :—

1.	2.	3.	4.	5.	6.	7.	8.
152	202	258	330	516	593	671	1034

The first three agree with lines found by Ellis for radium B, which is an isotope of lead; the fourth has been observed by de Broglie and Cabrera; 5, 6 and 8 correspond with the lines K, H and G of the β-ray spectrum of RaC. Strictly speaking, bismuth, which is the isotope of RaC, should have been employed to determine the last three lines, but the variations of the energies of the levels between RaB and RaC is of the order of the experimental errors. The γ-ray producing 5, which originates in the K level, and 6, which originates in the L level, has energy corresponding to 605,000 volts, while that producing 8, which originates in the K level, has 1,123,000 volts energy. The difference between the energies of the β-rays 5 and 6 is 77,000 volts, which corresponds well with the difference 76,000 volts between corresponding pairs of lines belonging to the K and L levels in the spectrum of RaC. The results have been confirmed, using radiators of platinum and uranium. It is necessary to assume, with Ellis, a level structure in the interior of the nucleus, and to apply the combination principle to the γ-rays. The author's results show that electronic drops take place within the nucleus, which greatly exceed 1,000,000 volts. Line 7 of the secondary β-radiation from lead, which is of medium intensity, has nearly the same energy as a rather weak line in the spectrum of RaC, which has not been assigned either to the K or L layers. **H. N. A.**

HEAT.

2123. *A Direct-Reading Pyrometer of the Disappearing Filament Type.* **F. H. Schofield and D. C. Gall.** (Journ. Sci. Instruments, 1. pp. 193–198, April, 1924.)—The normal working range of an instrument of the disappearing filament type is about 700°–1400° C. As it is usually calibrated in terms of the current passing through the filament, it means that about the first half of the ammeter scale is wasted. Further, it is not convenient to engrave direct reading temperature scales on the ammeter, since it is difficult to replace a broken lamp by another one having an identical current-temperature relationship. To overcome these drawbacks the authors have devised a bridge method in which the pyrometer lamp forms one arm, the other arms, *a*, *a*, *d*, being of manganim (see diagram). The value of *d* is so chosen that with the filament running at any particular temperature (say 700° C.) the bridge is balanced. If now the current in the bridge is increased by adjusting the rheostat *r*, there will be an out-of-balance deflection in the galvanometer. The resistance in series with the galvanometer is fixed at such a value that the extreme end of the scale is made to correspond with a certain upper limit of temperature (say 1300° C.). It is shown that the scale law for this bridge arrangement is approximately the same as the current-temperature relationship of the filament. A small Weston ammeter may be used as a galvanometer, and if the balance position is chosen somewhere between the extremes of the desired range of temperature, the deflection in *both* directions can be utilised by reversing the main current, thus utilising double the length of the dial. It is found, for a similar batch of lamps, that if the ends of the temperature scales are made to correspond by suitable choice of the resistances *a*, *a*, *d*, *b*, then the intermediate points will coincide closely. [See also Abstract 111 (1924).]



W. C. S. P.

2124. *A Sensitive Optical Lever Method for Measuring the Thermal Expansion of Small Specimens.* **J. Guild.** (Journ. Sci. Instruments, 1. pp. 198–204, April, 1924.)—The method employed is a comparative one, the quantity measured being the difference in expansion between the specimen under test and an equal length of material for which the coefficient is known. The specimens are made with flat and parallel ends, and stand side by side on an optically flat surface. A second optically flat surface rests on three small spheres, two of which are seated on the upper end of one of the specimens, the third being supported by the other specimen. At least one of the plates must consist of transparent material, so that light may be employed to measure the inclination between them. A plate of glass about 5 mm. thick and of good optical quality is placed in front of the eye-piece of a small astronomical telescope, so as to reflect light from a horizontal slit to produce an image of the slit in the focal plane of the objective. If the emergent light falls on a flat reflecting surface approximately at normal incidences, the reflected beam will re-enter the telescope, and a real image will be formed in its focal plane. Any rotation of the reflecting surface will be accompanied by a shift of this real image, and the change in inclination is measured on a micrometer scale placed in the focal plane of the eye-piece of the telescope. When using this arrangement for expansion measurements, the beam from the telescope is partially reflected both from the surface supporting the specimens and from that supported by them. The separation of the images measures the departure from parallelism of the two surfaces. Precautions are taken to eliminate undesirable reflections. In practice use is made of a series of parallel slits (illuminated by means of a 500-c.p. "Pointolite" lamp) in order to increase the range of the apparatus. Readings on the eye-piece scale can be made to 0·01 mm. As the magnification of the optical lever is 389·6, this corresponds to the measurement of a change in length of approximately $\lambda/20$ for green light. The method is suitable for specimens of any length up to 5 or 6 cm., and was originally devised for work on the expansion of optical glass. W. C. S. P.

2125. *Specific and Latent Heats of Iron and Steel.* **A. Mallock.** (Nature, 113. pp. 566–567, April 19, 1924.)—The rate at which heat is lost for a given change of temperature above and below the point of recalescence does not seem to have been fully investigated. Experiments are described [see Abstract 1835 (1924)] in which iron and steel wires were heated and cooled and the variation of length with temperature was automatically recorded in terms of time. In one series the wire was slowly heated and cooled in a tubular furnace, and in another series the heating was effected by means of an electric current passed through the wire. Both series were carried out in an atmosphere of nitrogen. The contraction curve recorded during furnace cooling showed no trace of any peculiarities at the temperature of recalescence, whereas the curve recorded during the air-cooling consisted of three separate parts, namely, (*a*) that from the highest temperature to the temperature of recalescence, (*b*) from the beginning to the end of the duration of recalescence, (*c*) from the end of recalescence to the ordinary temperature. Both the curves (*a*) and (*c*), as also the furnace-cooled curve, can be very closely represented as exponential functions of the time. It is suggested that with perfectly pure iron, at the temperature corresponding with the intersection of the two curves, the change of state would be instantaneous, no heat would be rendered latent, and the only change would be in the specific heat. C. O. B.

2126. *The Specific Heats of Magnesium, Calcium, Zinc, Aluminium and Silver at High Temperatures.* **E. D. Eastman, A. M. Williams** and **T. F. Young.** (Am. Chem. Soc., J. 46. pp. 1178–1183, May, 1924.)—Measurements of the specific heats of these metals were carried out by the method of mixture in the temperature intervals between 100° C. and the melting-points of the metals. The results obtained are estimated to be correct to about 1%. A transition point in calcium at about 400° C. was revealed by a break in the "total-heat" curve at this temperature, which was confirmed with a second sample and also with several differential cooling curves. No evidence of transition points which have been reported in the literature for zinc could be detected either by the mixture method or the cooling curve method. W. C. S. P.

2127. *Convective Cooling in Liquids—Some Thermal Conductivity Data.* **A. H. Davis.** (Phil. Mag. 47. pp. 972–975, May, 1924.)—In some previous work by the author [see Abstract 340 (1923)] on the cooling of horizontal wires in various liquids, it was assumed that the thermal conductivities of the liquids were independent of the temperature. C. W. Rice, however, has deduced for these liquids a positive temperature-coefficient of about 1 % *increase* per degree temperature rise. To test this result the author has carried out tests by the Goldschmidt method, an electric current being passed along a fine platinum wire placed along the axis of a horizontal silver tube filled with the test liquid. The current necessary to maintain a measured difference of temperature between the wire and the walls of the tube was measured. For each liquid the experiments were carried out at two or three temperatures in the range 15°–80° C., and the results show for toluol and carbon tetrachloride temperature-coefficients of $-0{\cdot}002$ and $-0{\cdot}003$ per degree C. respectively. Very small negative values were obtained for olive oil and aniline. W. C. S. P.

2128. *The Thermal Energy of Electrons in Metals.* **E. D. Eastman, A. M. Williams** and **T. F. Young.** (Am. Chem. Soc., J. 46. pp. 1184–1196, May, 1924.)—It has been generally assumed that because the atomic heats of most metals are approximately 3R at ordinary temperatures only a very small part of their heat capacity is due to their electrons. At high temperatures the specific heats of many metals are known to exceed 3R considerably, but it is not known how much of this excess is due to the difference of their specific heats $C_p - C_v$, *i.e.* to the work of expansion of the metal. The authors have therefore collected values of C_p of a number of metals at high temperatures and made a study of the dependence of $C_p - C_v$ upon temperature. It has been found that the simple empirical equation $C_p - C_v = kT$ fits all the data tested. From a critical examination of the data examined it is concluded that the excess of C_v over 3R in the case of most metals cannot be explained by an assumed departure by the atoms from simple harmonic oscillations. The fact that "excess" heat capacity frequently corresponds with electropositive character of metals is taken to support the view that the explanation is to be found in the presence of loosely bound electrons in the metals. At fairly high temperatures the high value of the heat capacity is due to the rate of gain of thermal energy by these electrons. Some apparent exceptions may be due to variation among the metals of the number of electrons involved in the effect. T. B.

2129. *Probability of Quantic States.* **E. Fermi.** (Accad. Lincei, Atti, 32. ii. pp. 493–495, Dec. 16, 1923.)—The probability $p = \epsilon^{-w/KT}$ of any particular state of an atom, with corresponding energy w, leads if $w = -A/i^2$ to $p = C\epsilon^{A/KTi^2}$, in which $C = \infty$, if all quantic states be possible. The author reaches an expression for the number of atoms in each quantic state, for which the energy per atom is w and the atomic volume is v; namely, $n = C \,.\, \epsilon^{-w/KT} \,.\, \epsilon^{-4Nv}$, where N is the whole number of atoms per unit volume of the gas and C is determined by the condition that $\Sigma(n) = N$. The number of quantic states cannot be high at ordinarily low pressures. A. D.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

2130. *Transformation of Electric and Magnetic Forces in a Plane Wave, in a Plane Normal to the Direction of Relative Motion of Two Observers.* **V. Karapetoff.** (Phys. Rev. 23. pp. 239–244, Feb., 1924.)—Two observers are assumed to move along the X axis and to measure the components of the electric intensity $E(E_1, E_2, E_3)$ and magnetic intensity $H(H_1, H_2, H_3)$ of a plane electromagnetic wave propagated at an arbitrary angle to the X axis. According to the theory of relativity, the two observers will find the same values of the components E_1 and H_1 along the X axis. The components E_2, E_3, H_2, H_3, along the Y and Z axes, are replotted in a novel manner in the so-called computing plane, which consists of two sets of oblique coordinates. The angle comprised by each set is uniquely determined by the relative velocity of the two observers. In the computing plane a transformation point M is located such that its abscissa and ordinate with respect to one set of oblique axes gives the components E_2 and H_3 of the wave intensities as measured by one of the observers, while its coordinates with respect to the other set of axes gives the values of the same components as measured by the other observer. Another transformation point N gives the components E_3 and H_2 for the two observers. It is shown that the loci of M and N are ellipses. The results obtained are shown to check with the well-known equations of the theory of relativity. The location of the points M and N is shown in two simple special cases, and instructions are given for locating them in the general case. AUTHOR.

2131. *Diurnal Variation of the Potential Gradient of Atmospheric Electricity.* **S. J. Mauchly.** (Nat. Research Council, Bull. 7. pp. 131–135, Jan., 1924. Abstract of report to Am. Geophys. Union, April, 1923.)—A less detailed account of results published in another paper [see Abstract 591 (1924)]. M. A. G.

DISCHARGE AND OSCILLATIONS.

2132. *The Active Agents in Luminescent Zinc Sulphides, Willemites and Kunzites.* **T. Tanaka.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 659–667, May, 1924.)—The chief active agent is difficult to determine owing to the numerous impurities in zinc ores, of which Fe, Cd, Cu and Mn are very frequent. Previous researches are briefly discussed, from which the author deduces that the origin of the luminescence of zinc sulphide is probably some agent or agents in solid solution. Since pure zinc sulphide is almost impossible to obtain, even a highly fractionated sample will show a perceptible luminescence. The active agent, which is probably very difficult to separate from zinc sulphide, may alone be unable to produce any prominent luminescence, but may require the presence of some salt as a flux—an effect known in the case of Lenard and Klatt's sulphides. From the latter the amount of active metal giving maximum brightness of luminescence is found to be of the order of 0·01 %, so that traces of an impurity too minute for chemical analysis may show very remarkable luminescent power. Experiments are now described on four samples of zinc sulphide and two of zinc blende, 48 luminescence bands being found which belong to three constant-frequency-interval series, having intervals of 17·4, 17·7, and 18·2 (in 1/Å.U. × 10^7 units). The bands of the first series coincide with those of thallium; those of the second series do not appear to belong to any of the 42 metals previously studied [Abstract 1889 (1924)]; and the third nearly coincide with those of erbium. The author is of the opinion that the latter is accidental, and both the second and third series are due to ytterbium. Crookes' work is extensively quoted, and support afforded for the latter conclusion by a comparison of Crookes' bands with those found by the author, in which the correspondence is good for ytterbium, but not for the other rare earths. Very complete data are included for the sulphides, and also for Willemites and Kunzites. H. H. Ho.

2133. *The Current-Voltage Relation in the Corona.* **C. S. Fazel** and **S. R. Parsons.** (Phys. Rev. 23. pp. 598–607, May, 1924.)—*An equation* is derived on the basis of a small region (of radius a) of intense ionization around the wire, outside of which the current is carried only by ions of one sign, whose space density ρ is constant. At the boundary between the two regions the field is assumed to be the minimum field required to start the corona, and the field beyond is taken to be the sum of the electrostatic field and that due to the space charge. Putting in the experimental result that a is a linear function of the applied voltage V, the equation for the current i is put in the form $i = cV(V - V_0)/(V_1 - V)$, when c is a constant proportional to the mobility. *Measurements* with a brass tube 17·8 cm. long and 4·75 cm. inside diameter, through which a slow stream of dried or moist air was passed, show good agreement with the above equation, as far as variation with V is concerned, for voltages from 4·7 kv. to 8·8 kv., for temperatures from 290° K. to 417° K. and for moisture content up to 44 per cent. The theory is evidently imperfect, however, as the absolute values of the mobilities come out from two to four times the values obtained in small fields, although the variation with absolute temperature is correct. AUTHORS.

2134. *Dissociation of Hydrogen and Nitrogen by Excited Mercury Atoms.* **O. S. Duffendack** and **K. T. Compton.** (Phys. Rev. 23. pp. 583–592, May, 1924.)—*Dissociation of Hydrogen in Low-voltage Arcs.*—Arcs were maintained from a heated Mo filament to a Ni anode, and the rate of dissociation was measured by the change of pressure produced as a result of oxidation of the atomic hydrogen by nearby copper oxide and of freezing out of the resulting water-vapour. *In pure hydrogen* there is no dissociation, other than that due to the hot cathode, below a minimum voltage (13), but above the minimum arcing voltage (16) the rate was rather rapid, decreasing somewhat with increasing voltage to 65, the highest tried. *In mercury arcs*, however, the dissociation was at least ten times more rapid in the 5-volt arc and three times more rapid in the 10-volt arc. This rapid dissociation is attributed to collisions of the "second kind," whereby the H_2 molecules receive energy for dissociation from excited Hg atoms in the $2p_2$ state.

Dissociation of Nitrogen in Low-voltage Arcs.—Similar experiments with nitrogen, using pure Mg metal to absorb the dissociated nitrogen, showed a dissociating *effect of excited mercury atoms*, but only about one-tenth as large as the effect in H_2. Reasons are given for believing that in N_2 the dissociation is produced by Hg atoms in the 2P state. This conclusion is supported by results obtained by others on the disappearance due to phosphorus vapour, but is apparently at variance with the similar effect of arsenic vapour. Clean-up *due to electron impacts*, 17 to 100 *volts*, is small to 25 volts, increases four-fold to 70 volts, and ten-fold for voltages above 70. The effect is related to the intensity of the line spectrum. Above 70 volts a very *active form of nitrogen* is produced, resulting in a "flare." AUTHORS.

2135. *Deposit of Metal Films by Kathode Sputtering.* **Lambert** and **Andant.** (Rev. d'Optique, 3. pp. 175–178, April, 1924.)—To be serviceable, apparatus for kathode sputtering must be easy to take to pieces. The use of greased joints makes it impossible to carry out the sputtering in pure gases, and apparatus is therefore described using a mercury seal, whereby a surface of 100 square centimetres can readily be subjected to sputtering. G. A. S.

2136. *The Emission of Positive Ions from Hot Tungsten.* **W. A. Jenkins.** (Phil. Mag. 47. pp. 1025–1047, May, 1924.)—These experiments relate to the emission currents from the tungsten wires of three Coolidge tubes. It was observed that at temperatures near the melting-point of tungsten the electron current diminished somewhat. This diminution was accompanied by the growth of a small positive current which increased rapidly with increasing temperature. These positive ions, which are almost unaffected by a magnetic field of 400 gauss, appear to be positively charged atoms or molecules of tungsten. Evidence is adduced to show that the effects observed are not due to photoelectric electrons liberated from the tungsten anti-cathode by the incidence of the light from the heated cathode. The positive emission is of a different order from the electron emission, being much smaller. At the highest temperatures the positive emission decreases rapidly with time, but at moderate temperatures the time-effect (if existent) is small. A. A. D.

2137. *The Action of a Transverse Magnet Field at the Cathode of the Glow Discharge.* **A. Günther-Schulze.** (Zeits. f. Physik, 24. 2. pp. 140–147, 1924. From the Reichsanstalt.)—In order to obtain a plane horizontal cathode surface, so arranged that disturbances from the glass walls of the containing vessel could be avoided, a glass tube was employed of 4 cm. diameter and 28 cm. long, sealed at one end, half-filled with mercury, and closed by a rubber stopper, through which passed a glass tube connecting it to the air-pump, an iron wire to form the anode, and a wire to make contact with the mercury. The tube was placed with its axis horizontal between the poles of an electromagnet, so that the lines of force were perpendicular to the axis and parallel to the surface of the mercury. A cathetometer was employed to measure the distance between the surface of the Hg and the edge of the glow. The magnet field did not affect the glow until the pressure was considerably reduced, when the discharge was deflected from its original position immediately below the anode; this was bent vertically downwards so as to point to the axis of the tube at a point fairly near the rubber stopper; the glow then formed a narrow band, which, by increasing the magnetic field, could be elongated in the direction of the axis of the tube almost to its end, but which was in all cases sufficiently far from the glass walls not to be influenced by them. Tables and curves are given showing the relation between the thickness of the dark space (fall space), d, and the magnetic field for H, N, Ar, Hg and H_2O; it was found that for all of these there is a minimum value of this thickness, d_v, of about 0·70 mm., and the strongest magnet field will not reduce d below this value. At low pressures d, without the field, may be very much greater than this, but a sufficiently powerful field reduces it to this value; at higher pressures d does not differ greatly from d_v, even when there is no field. H. N. A.

2138. *Overdamped Condenser Oscillations.* **C. P. Steinmetz.** (Am. I.E.E., J. 43. pp. 424–428, May, 1924.)—The standard equations for the discharge of a condenser through an inductive circuit show that the discharge is oscillatory if the resistance of the discharge circuit is less than the critical value, and impulsive if the resistance is greater than $\sqrt{4L/C}$. This, however, only holds if the circuit factors—resistance, inductance and capacity—are actually constant, and does not apply if the resistance is that of a third-class conductor, *i.e.* if the p.d. across the resistance decreases with increasing current. In this case the discharge is always oscillatory. Further, even with constant values of resistance, inductance and capacity, the classical condenser discharge equations hold only for the ideal condenser, *i.e.* a condenser having no energy losses. If energy losses occur in the condenser, the discharge remains oscillatory even for values of the discharge resistance greater than the critical value $\sqrt{4L/C}$, and the discharge oscillates the more, the higher the energy losses in the condenser. However high may be the resistance of the discharge circuit, there always exists a value of the energy loss in the condenser at which no impulsive discharge is possible, and for which the discharge is always oscillatory. The frequency of the oscillation, and the limit to which the discharge is oscillatory, depends upon the difference between the power dissipation in the discharge resistance and that in the condenser losses, whilst the attenuation or damping of the discharge-wave depends upon the sum of the losses. As a result of the combined losses, such discharge-waves may have rates of attenuation far greater than is possible from the equations of the ideal condenser; they may thus be called overdamped oscillations. In such overdamped discharge oscillations of the imperfect condenser, only a fraction of the first half-wave may be of appreciable magnitude. The wave-front is very much steeper than the wave-tail, similar to the case with the non-oscillatory impulse; the wave-shape, however, differs from this latter case, as the current and voltage pass through zero at a definite point, whereas with the non-oscillatory impulse they gradually fade out. In the mathematical treatment of the subject the author shows that for the case of a perfect condenser shunted with a conductance g, the discharge is oscillatory when $r < \sqrt{4L/C} + gL/C$. Oscillograms are given confirming the theory.

A. E. C.

2139. *Behaviour of Hertz Gratings: Remarks on Treatment by R. Gans.* **C. Schaefer.** (Ann. d. Physik, 74. 3. pp. 275–284, May, 1924.)

—It was impossible for the author to compare some of his previous experimental results with theory, as at that time no theory existed on the behaviour of Hertz gratings. This lack has recently been filled by R. Gans, who has given an approximate theory. This, however, does not quite accord with the experimental results, but the present author here modifies the theory to take account of dispersion, and with this theory the experiments are in good agreement, as shown by graphs. [See Abstract 907 (1920).] E. H. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

2140. *Disruptive Strength of Solid Dielectrics.* **A. A. Ahmed.** (World Power, 1. pp. 281–287, May, 1924.)—The author discusses the electric field between the electrodes used in testing solid dielectrics. The character of the field is found experimentally by using an electrolytic cell as described in a previous abstract [Abstract 1530 (1924)]. The conclusion is reached that the law of variation of the maximum stress with the thickness of the dielectric depends largely on the edge curvature when the average potential gradient is maintained at the same constant value for the various thicknesses. It approximates to a straight-line law for electrodes whose edges are rounded off to a radius of 0·25 cm. For smaller radii of edge curvature the maximum stress increases more slowly, and for larger radii more rapidly than the thickness. W. R. C.

2141. *The Dielectric Properties of Water for Continuous Waves.* **G. C. Southworth.** (Phys. Rev. 23. pp. 631–640, May, 1924.)—*Direct Measurement of the Refractive Index of Water for Continuous Waves of Length about 2 metres.*—In the method adopted continuous standing waves on wires were measured both in air and in water, and the refractive index determined as the ratio. Errors involved in the measurement of the length of waves in air, due to imperfect reflection and to the resistance of the guiding wires, were investigated. In the case of water it was found that measurements varied with the size of the tank unless the waves were guided into the water by conductors extending through the tank. The final arrangement is analogous to Kundt's tube for sound waves; the level of the water in a vertical tube, through which the parallel wires passed, was varied, and the nodes determined from the variation of the current from a thermocouple placed in the bridge of the Lecher system, located at the lower end of the water column. Thus a number of nodes were located. The mean result for the refractive index comes out 8·88 ± ·04, in good agreement with values obtained by others using discontinuous waves. This indicates that within the range of frequencies investigated, the group velocity of waves through water is the same as their phase velocity, within the accuracy of the measurements. No appreciable dispersion for the range of wave-lengths 124 and 276 cm. was observed.

An Oscillating Circuit for Producing Short Continuous Hertzian Waves, of length varying from 1 metre upwards, is described, in which the tube capacity is used as a means of coupling. AUTHOR.

2142. *Variation in Photoelectric Activity with Wave-Length for Certain Metals in Air.* **T. H. Osgood.** (Roy. Soc. Edinburgh, Proc. 44. 1. pp. 8–18, 1923–1924.)—Experiments are described from which it is concluded that if it is desired to use the photoelectric effect from a metal plate to estimate the physiological action of a given radiation, then it is preferable that the metal should be used in the steady state rather than when freshly polished, "fatigue" effects being thus eliminated, but that a silver plate, being comparatively free from fatigue, may be used where sufficient time for the assumption of the steady state is unavailable. It is shown that, since the skin is not affected by ultra-violet light of wave-length greater than 0·25 μ, and since there is little germicidal action beyond 0·29 μ, Zn and Al are unsuitable for this purpose, having a very considerable photoelectric activity on the long-wave side of 0·29 μ. If germicidal effect need not be considered, Au becomes suitable, giving no photoelectric current beyond 0·26 μ. A. B. C. L.

2143. *Effect of Torsion on Thermal and Electrical Conductivities of Metals.* **J. E. Calthrop.** (Phys. Soc., Proc. 36. pp. 168–174; Disc., 175, April, 1924.)—The method previously described [Abstract 322 (1924)] is used for determining the changes in the conductivities of wires of brass, iron, zinc, nickel and tin. As before, the decreases are found to be proportional to the squares of the twists, and the changes in the electrical are smaller than the corresponding changes in the thermal conductivities. The electrical conductivities return to their normal values after the removal of the twist, but this is not always so in the case of the thermal conductivities. For iron there appears to be a slight return of the thermal conductivity towards its original value, although the twist is kept constant. The decreases are of the same order in whatever sense the twist is carried out; they are much greater than can be accounted for by a change in dimensions of the specimen, as has been suggested. G. A. S.

2144. *The Atomic Electrical Conductivity of Metals.* **F. Simon.** (Zeits. f. Physik, 109. 1–2. pp. 136–142, 1924.)—The atomic conductivity is defined in relation to a cube containing 1 gramme-atom of the metal, and is equal to $cV^{\frac{1}{3}}$ where V is the atomic volume and c the specific conductivity per cub. cm. For comparative purposes it is necessary to evaluate the conductivities at corresponding temperatures. These temperatures are determined on the basis of considerations put forward by Nernst, Grüneisen, and Lindemann. The conductivities at these temperatures are then calculated from the most trustworthy published data. These values are shown attached to the metallic elements in the Periodic table, and it may be seen that elements in the same sub-group have approximately equal conductivity. It is concluded that the atomic conductivities at corresponding temperatures are equal for elements which have the same arrangement of their outer electrons. In addition, the fewer the outer electrons the greater the conductivity. The paper concludes with some considerations of the conductivity in different directions in crystals of zinc and cadmium, from which it appears that the conductivity is related to the atomic frequency in the direction of the current and not to the frequency at right angles. A. A. D.

2145. *A New Induction Coil for Determination of Conductivity worked from a Direct-Current Lighting Circuit.* **F. Scheminzky.** (Zeits. phys. Chem. 109. 5–6. pp. 435–437, 1924.)—A condenser K_1 is connected to the lighting circuit through a large resistance W_1; across the terminals of K_1 one of three different resistances, W_1, W_2 and W_3, is connected in series with a second condenser K_2, and across the terminals of this condenser the primary of the induction coil and a diode "glim lamp" are connected in series; the telephone is connected to the secondary of the induction coil. Oscillations are set up in the circuits the frequency of which depends on the capacity of K_2 and on the resistance in series with it (W_2, W_3, or W_4). One advantage of the apparatus is that, except for the sound in the telephone, it is noiseless. H. N. A.

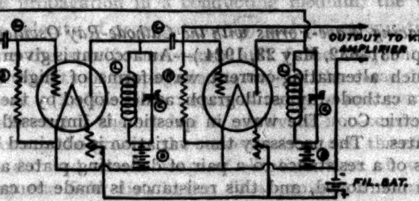
2146. *Nagaoka's Correction Factor K.* **E. J. Hobbs.** (Wireless World and Radio Rev. 14. pp. 260–261, May 28, 1924.)—A nomogram is given for the purpose. W. R. C.

2147. *Electrolytic Capacity and Resistance of Pt-Rhodamine B-Pt Cell, as Determined by a Phase-Angle Method of Measurement.* **K. F. Sun.** (Phys. Rev. 23. pp. 617–630, May, 1924.)—*Direct Measurement of the Phase Angle of Any Reactive Circuit.*—The circuit is placed between A and B in one arm of a bridge, an adjustable resistance R between B and C, two equal resistances between A and D and between D and C. An e.m.f. E is applied at A and C, and the potential difference between B and D is determined by applying a known e.m.f. in quadrature with E and adjusting for zero current. For highest sensitiveness, R should equal the impedance of the reactive circuit. The sensitiveness increases with decreasing frequency. The method is useful in testing any autotransformer. A direct-current galvanometer was connected in series with a synchronous commutator, permitting independent adjustment of E and R for zero current.

Electrolytic Capacity and Resistance of Pt-Rhodamine B-Pt Cell was measured by the phase-angle method for various cells with electrodes of solid Pt or of cathodically deposited films of various thicknesses in various relative positions. The results can be regarded as correct only when the electrodes have relatively small resistance. For the case of two parallel plates, the correction for the resistances of the electrodes is made. *Variations with e.m.f. and frequency.* The resistance is constant, but capacity increases with e.m.f. for values above 0·4 volt and decreases with frequency in proportion to $1/\sqrt{f}$ for 10 to 70 cycles. *Variation with arrangement of electrodes.* A cell with parallel solid electrodes has a greater capacity than one with the same electrodes lying in a plane. The capacity increased as the thickness of the sputtered film decreased, and was greater for films with a black colour. *Effect of increasing concentration and temperature* was to increase the capacity and decrease the resistance. AUTHOR.

2148. *Methods of Varying the Sensitiveness of Ballistic Galvanometers by Adding Series Resistance.* **M. Masius.** (Phys. Rev. 23. pp. 649–654, May, 1924.)—On closed circuit, the added series resistance does not change the throws in the inverse ratio of the circuit resistances because of the simultaneous change in electromagnetic damping. However, if the added resistance r_2 required to reduce a given throw to half-value is determined by measurement so that $r_2/G = n_2$ (where G is the original total resistance of the galvanometer circuit) is known, then n_5 and n_{10} and the corresponding resistances r_5 and r_{10} required to reduce the throw to one-fifth and one-tenth can be obtained from a table which is given. A slight amount of air-damping does not affect the results, but for galvanometers with a special damping-coil this table does not hold. The complication due to the change of the damping may, however, be readily eliminated if a special switch is used to open the galvanometer circuit immediately after the induced charge has passed. In this case, even with strongly damped galvanometers, experiment shows that the deflections are inversely proportional to the total resistance of the galvanometer circuit. AUTHOR.

2149. *A Source of Constant-Frequency Oscillations.* **R. Gunn.** (Optical Soc. of America, J. and Rev. Sci. Inst. 8. pp. 545–547, April, 1924.)—The author describes an electrical oscillator which maintains the frequency virtually constant under conditions of varying filament current and anode potential. If a given voltage be impressed on the grid of one tube, the effect of this voltage will be passed on to the next one, which will repeat the operation and return to the original grid the same impulse amplified and approximately in phase with it. Thus the system will oscillate, and all frequencies are rapidly attenuated except the one for which the coupling unit is designed. L and C should be of such a value as to give the desired frequency, and should be so proportioned that the tuning is fairly sharp (*i.e.* $\frac{1}{R}\sqrt{\frac{L}{C}}$ should be made as large as possible). The value of C_g should be such that its impedance at the desired frequency is small compared with the input impedance of the tube. In some cases chokes and biasing batteries are used to advantage, and if more than 5 or 10 per cent. of the rated power of the tubes is to be used, it is advisable that the output leads be connected to an amplifier.



The following are the details of an oscillator for 1000 ∿. L_1 and L_2 are similar, and made by winding a slot ⅞" deep cut in a 3½" circular block full of No. 27 B. & S. enamelled wire inductance, approx. 230 millihenries:—

Short condensers, C_1 and C_2, 0·1 μ F. (with a variable position to increase to 0·12 μ F.).
Grid condensers C_g, 0·25 μ F.
Tubes, Western Electric coated filament.
Plate voltage, 45.
Iron core choke 0·8 henry, 600 ohms } used in place of grid resistance.
Negative grid bias, 4½ volts }

On an oscillator similar to the above it was found by beat methods that the frequency variation was less than 1/10 per cent. for a plate voltage change of 50 per cent, and a change of 3/10 per cent. for a 43 per cent. change in filament current. W. C. S. P.

2150. *Coils with Variable Inductance for Audio Frequencies.* **H. Winter-Günther** and **J. Zenneck.** (Phys. Zeits. 25. pp. 210–212, May 1, 1924.)—In experiments with alternating currents of frequencies in the neighbourhood of 500 per sec. coils with variable inductance are not easy to construct. The arrangements ordinarily used for lower frequencies have too much iron, and iron-free coils of sufficiently large inductance become very cumbrous if their resistance has to be small. A simple arrangement of two coils (whose position along an iron core can be altered) is here described, which gives a wide range of values for the inductance, combined with low d.c. resistance. The iron core, which is 50 cm. long, is made up of very thin sheet-iron stampings with paper insulation. One core used had a cross-section $3 \times 2 \cdot 7$ cm.^{2}, another being $3 \times 5 \cdot 4$ cm.^{2}. With the former, using coils of 119 turns of wire $1 \cdot 5$ mm. diam., an inductance of about $0 \cdot 023$ henry is obtained with the coils touching one another at the middle of the iron core, while the inductance with coils just off the ends of the core is only about $0 \cdot 002$ henry, the variation being roughly linear until the coils are near the ends of the core. Using the double core and coils of 224 turns, inductances from $0 \cdot 09$ to about $0 \cdot 0025$ henry may be obtained. Curves are given showing the variations in inductance and effective resistance as functions of the distance apart of the coils. A. W.

ALTERNATING CURRENTS AND MAGNETISM.

2151. *Tracing Wave-Forms with the Cathode-Ray Oscillograph.* (Electrician, 92. pp. 631–632, May 23, 1924.)—An account is given of an arrangement by which alternating-current wave-forms of high frequency can be traced by a cathode-ray oscillograph, as developed by the International Western Electric Co. The wave in question is impressed on a pair of deflecting plates. The necessary time variation is obtained by connecting the terminals of a resistance to a pair of deflecting plates at right angles to those just mentioned, and this resistance is made to carry a current which varies periodically with the time. Suitable current for this purpose is obtained by having this resistance as part of a closed circuit containing a battery and neon lamp in series. The lamp is shunted by a variable condenser. As is well known, the lamp in these conditions will light up periodically. The charging current, on switching on, increases at a rate dependent on the capacity, and the cathode rays will accordingly be deflected until the point is reached when the neon lamp lights up. The condenser then discharges, so that there is a rapid fall in the current until the lamp becomes extinguished and the process is repeated. Thus the wave-form is traced on the bulb of the oscillograph, and, if the variable capacity is adjusted so as to give synchronism, a steady trace of the wave-form is obtained. W. R. C.

2152. *Vector Diagrams and Algebraic Signs in Alternating-Current Theory.* **H. Kafka.** (Elek. u. Maschinenbau, 42. pp. 329–333, May 25, 1924.)—Confusion in alternating-current problems can only be avoided by clearly recognising the fact that algebraic equations and vector diagrams expressing the connection between p.d.s or e.m.f.s and currents possess no meaning unless definitely correlated to a circuit diagram in which the various directions assumed as positive for voltages and currents are clearly marked. The author considers the general case of a network to which are connected generators and consuming devices, and adopts the p.d. vector across the mains as the vector of reference. After considering the expressions for the power and wattless components of currents and the power and wattless components of the volt-amperes, he advances reasons for the adoption of the following rules as, on the whole, the least likely to occasion confusion: (1) The *same* directions should be adopted as positive for both generating and consuming devices; (2) p.d.s and currents should be assumed to have similar directions (this in spite of the fact that in the case of a circuit consisting of a single generator supplying a single consuming device two equal but oppositely directed currents would be assumed to exist in the two portions of the circuit). A. H.

2153. *Distribution of the Magnetic Field and Return Current Round a Submarine Cable Carrying Alternating Current.* **C. V. Drysdale.** (Roy. Soc., Phil. Trans. 224. pp. 95–140, April 14, 1924.)—This paper gives a description of theoretical work, and also of experimental work carried out chiefly at Harwich and in the Gareloch, relative to the distribution of the magnetic field and return current round a "leader" cable. The experimental arrangements are described in detail, and the results are presented in graphical and tabular forms. The results appear to justify the following conclusions: (1) The propagation of plane electromagnetic waves in sea-water appears to take place in close accordance with the theory of wave propagation in a conducting medium, the wave-length being $\sqrt{\rho/f}$, the velocity of propagation $\sqrt{\rho f}$ and the attenuation constant $2\pi\sqrt{f/\rho}$, ρ being the specific resistance and f the frequency. At low frequencies the velocity of propagation is only of the same order as that of acoustic waves. (2) The return current tends to concentrate near to the cable and above it if the sea-bed is relatively non-conducting. The higher the frequency the greater the concentration, and the effect appears to be that of a diffused mirror image of elliptical form above the cable, causing the magnetic field distribution to approximate more and more nearly to that produced by a pair of leading and return conductors in a vertical plane as the frequency is increased. (3) The variation of phase of the return current in the water above the cable appears both by theory and experiment to correspond fairly closely with the propagation of plane electromagnetic waves in an infinite sea. (4) The fundamental equations for wave propagation in a conducting medium lead to a principle of similitude by which the whole of the phenomena can be reproduced in another medium of similar form if the scale is altered in the ratio $\sqrt{\rho/\mu f}$, or of the wave-lengths for the two mediums. In this way the field distribution at large distances from the cable can be determined by employing a sheet of lead in place of the water. (5) The magnetic field at the surface vertically above the cable diminishes with increase of depth, both due to increase of distance from the cable and to absorption. The latter appears to follow an approximately exponential law agreeing fairly closely with theory. (6) Armouring a submarine cable produces a marked diminution of the magnetic field and of the return current in the water, owing to the concentration of the return current in the sheath. The effective or resultant current found by experiment is in fair agreement with the theory of Oldenburg at frequencies in the neighbourhood of 500 cycles, but is lower than the theoretical value at low frequencies.

(7) The experiments on a steel ship give a distribution of the lines of force above the surface which differs from that obtained with a wooden vessel. The explanation apparently lies in the greater electrical conductivity of the hull as compared with the water; this causes a considerable concentration of the return current in the hull, thus producing a magnetic field encircling the hull. Calculations made by S. Butterworth support this hypothesis. A. W.

2154. *Distribution of the Magnetic Field and Return Current Round a Submarine Cable carrying Alternating Current.* **S. Butterworth.** (Roy. Soc., Phil. Trans. 224. pp. 141–184, April 14, 1924.)—This paper gives a comprehensive theoretical treatment of the problem of the "leader" cable, and also describes experimental verification of the theory by means of a model in which sheet lead of different thicknesses was used to represent the sea. The results obtained in the Gareloch [see preceding Abstract] are also discussed in relation to theory. The agreement between the experimental results and the theory is sufficiently close to justify the conclusion that the formulæ derived are essentially correct. A. W.

2155. *Electrical Diagrams in Three Dimensions.* **J. Wotschke.** (Elekt. Zeits. 45. pp. 528–529, May 22, 1924.)—The author describes the uses to which diagrammatic curves in three dimensions, on the principles of solid geometry, can be put for the purpose of explaining graphically certain electrical phenomena, such as the efficiency of a synchronous generator, which is variable, depending both on power factor and output. W. H. S.

2156. *Dielectric Constants of Liquid Crystals in a Magnetic Field.* **Jezewski.** (J. de Physique et le Radium, 5. pp. 59–64, Feb., 1924.)—Using a method described previously [see Abstract 752 (1923)], the author tests the dielectric constants of a large number of liquids in a magnetic field. The liquid was held in a box-shaped condenser which formed part of an oscillating circuit, the wave-length used being 720 metres. It was found that when a longitudinal magnetic field was applied, the capacity of the condenser decreased; no change was observed when the field was transverse. The results, given in tables and graphs, show that liquid crystals are electrically anisotropic; the difference between the dielectric constants, without and with the field, increases with the field strength, reaching a limit in a field of about 2000 gauss. The difference diminishes with temperature. G. E. A.

2157. *Reluctivity of Permalloy.* **A. E. Kennelly.** (Frank. Inst., J. 197. pp. 623–627, May, 1924.)—The remarkable magnetic properties of permalloy, a nickel-iron metal [see Abstract 2282 (1923)], include permeability much greater than that of soft iron. It is known that the metallic reluctivity $1/(\mu - 1)$ of soft iron, cast iron and steel is in each case a bilinear function of the field. The author, using data obtained from the graphs of Arnold and Elmen, plots reluctivity against magnetising force for permalloy and Armco iron. The graphs obtained indicate minimum reluctivity for permalloy at about $H = 0{\cdot}06$ gilbert per cm., and for Armco iron at about $H = 1{\cdot}4$. Permalloy is no exception to the general rule for magnetic metals in this respect, its bilinear graph being well maintained at least as far as $H = 4{\cdot}0$. G. E. A.

2158. *The Energy Change in Iron and Nickel at the Critical Temperature.* **J. R. Ashworth.** (Phil. Mag. 47. pp. 848–859, May, 1924.)—Using a heating method to suppress hysteresis in iron and nickel wires, anhysteretic curves are drawn for these metals from which by the use of equations for the ferromagnetic and paramagnetic states the values of the constants in these equations are determined. It is shown that the principle of corresponding states applies to curves of $I = \phi(H)$ for iron and nickel. For anhysteretic isothermals $H\{1/I - 1/I_0\} = R_1T$, I_0 being maximum intensity; and R_1I_0 relates to the energy per unit of temperature in the ferromagnetic state below the critical temperature, while $R'I_0^2$ is the energy per unit of temperature above the critical temperature. Since $R_1I_0^2$ has the value 2 for iron and 1 for nickel, and R_1 is negligible compared with R', it is concluded that in passing through the critical temperature there is a change of kinetic energy per unit of temperature equivalent to that of two degrees of freedom, the molecular weight above the critical temperature being 55·85 for iron and 2 × 58·68 for nickel. G. E. A.

2159. *Soft-steel Cylinders in Strong Magnetic Fields.* **P. Dejean.** (Comptes Rendus, 178. pp. 1370–1372, May 14, 1924.)—The intensity of magnetisation of 120 extra-soft steel cylinders arranged so that their axes were in line has been measured for different values of the gap between successive cylinders [Abstract 1948 (1921)]. This has now been done with the axes still parallel, but displaced sideways so as to form helices. Curves are given incorporating the results. A. C. M.

2160. *Charging Effect of Prolate Iron Spheroid Rotating in a Magnetic Field.* **E. Lawrence.** (Phil. Mag. 47. pp. 842–847, May, 1924.)—The work of Swann on the "moving-line theory" of electromagnetic induction [see Abstract 1635 (1920)] is extended to the case of a prolate spheroid the formulæ for which have been worked out by Rognley [see Abstract 188 (1923)], who found an expression for the alteration of potential of the axis produced by rotation. When the axis is earthed, this change results in the charging of the ellipsoid. An iron ellipsoid with major axis 20 cms. and minor axis 2 cms. was mounted in a brass shell placed within and insulated from a magnetising solenoid. The ellipsoid was rotated at high speed while the insulated shell was in connection with a Dolezalek electrometer. Measurements of the potential of the shell at various speeds are compared with the potentials as calculated and the two agree within 3·4 per cent. The results are considered to be a satisfactory confirmation of the theoretical formula. G. E. A.

2161. *X-Ray Corpuscular Emission from Iron in a Magnetised and Unmagnetised State.* **G. A. Carse** and **D. Jack.** (Roy. Soc. Edinburgh, Proc. 43. 3. pp. 226–229, 1922–1923.)—Ewing [Abstract 1722 (1922)] has suggested that there is something in an atom which turns in response to an applied magnetic field. In this connection the authors now describe a study of the X-ray corpuscular emission from iron when magnetised and unmagnetised, especially under the influence of very penetrating rays. The experimental results indicate that in the iron atom, either the part of atom that turns does not emit an appreciable number of electrons, or the chance of ejection is not affected by the orientation produced by a magnetic field. A. B. W.

2162. *Magnetic Observations by the Carnegie Institution of Washington during the Total Solar Eclipse of September* 10, 1923. **J. P. Ault.** (Terrest. Magn. 29. pp. 1–12, March, 1924. Paper read before the Philosoph. Soc. of Washington, Dec., 1923.)—A preliminary discussion of special observations of magnetic declination, horizontal intensity and inclination made at Point Loma (California), and of declination at Mt. Wilson (California), and at Guatemala City (Guatemala). The readings are exhibited in tabular and in graphical form, and include observations on September 9th and 11th as well as September 10th. Declination observations are given as five-minute means, horizontal intensity as fifteen-minute means, and inclination as six-minute means. Magnetographs were not used, all observations being eye-readings.

The graphs show a marked eclipse effect corresponding to results obtained from previous eclipses. At Mt. Wilson and Point Loma the time of westerly elongation of the declination was advanced about two hours on the day of the eclipse, the effect beginning to be felt shortly after the time of first contact for the local eclipse, and continuing for some time after the last contact. At Guatemala City, easterly declination was increased shortly after the time of first contact, the effect reaching a maximum about one half hour after the time of maximum obscuration.

The horizontal intensity at Point Loma reached a maximum on September 10th, about one hour earlier than on September 9th and 11th. The inclination effect was small. The "eclipse effect" on magnetic declination (obtained by comparing September 10th with September 9th and 11th) seems to have been about 2′·5 at Point Loma, 3′ at Mt. Wilson and 1′·5 at Guatemala City, all showing an increase in easterly declination. The effect on horizontal intensity seems to have been about 60γ, showing first an increase to a maximum about 30 min. before totality, followed by a sharp decrease to a minimum about 30 min. after totality. The effect on inclination was to increase the northerly dip by over one minute shortly after totality. The effect on vertical intensity was about 80γ, the positive vertical intensity increasing to a maximum shortly before totality and then decreasing sharply to a minimum about 40 mins. after totality. M. A. G.

2163. *Magnetic Anomaly at Koursk.* **P. Lasareff.** (Comptes Rendus, 178. pp. 1301–1302, April 7, 1924.)—Further investigations in this region of Central Russia [Abstract 782 (1924)] indicate a second band of magnetic anomaly to the south of the first. The boundaries of this band are less defined than the former, but there is clear indication that the magnetic effects are independent of any atmospheric cause, and are due to a magnetic ore body. W. A. R.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

2164. *Supersaturation of Gases in Water and Certain Organic Liquids.* **J. Metschl.** (J. Phys. Chem. 28. pp. 417–437, May, 1924.)—By means of a special apparatus the following saturated solutions were prepared at pressures ranging from one to five atmos.: oxygen in water, alcohol, acetone, or carbon tetrachloride; nitrogen in water, aniline, nitrobenzene, alcohol, or benzene; air or hydrogen in water; carbon dioxide in water or alcohol. After each liquid had been saturated with the gas at high pressure, the latter was reduced to that of the atmosphere, and the residual supersaturated gas shaken from the liquid and its volume measured. The ratio of the volume so determined to the pressure at which saturation took place is practically constant for any given gas and liquid, the extent of the supersaturation being thus proportional to the pressure at which the saturation occurred. The graph obtained by plotting the volumes of gas shaken from a supersaturated solution against the pressures at which saturation took place is nearly identical with the solubility-pressure graph for the same gas and liquid corresponding with Henry's law. Thus, when these liquids are saturated at a high pressure and the pressure above the liquid is then reduced the total amount of gas corresponding with the difference in solubility between two pressures remains in the supersaturated condition. Notable exceptions to this rule are found with solutions of carbon dioxide in water or ethyl alcohol. T. H. P.

2165. *The Electric Supertension.* **A. Smits.** (Zeits. Elektrochem. 30. pp. 214–223, May, 1924.)—The paper deals more generally with the phenomena than the previous papers [Abstract 2337 (1923)], again mathematically on the complex theory of allotropy and by applying the phase rule. The metal is supposed to be complex and to consist of atoms, ions (of the same or different valencies) and electrons, and possibly further of molecules; these particles may be in inner equilibrium with one another, subject to certain retardations. In contact with an electrolyte, the metal becomes surrounded by a layer of liquid which will be in heterogeneous equilibrium, whether the metal be dissolved or precipitated, though the thickness of the layer may vary. The author distinguishes between hydrogen in a state of formation and hydrogen in the nascent state, the latter being the state which precedes the appearance of the hydrogen phase. H. B.

2166. *H. F. Weber's Method for the Determination of the Coefficient of Diffusion of Liquids.* **F. Hoeltzenbein.** (Zeits. f. Physik, 24. 1. pp. 1–9, 1924.)—Weber's method for determining the diffusion coefficients of salt solutions consists in immersing two reversible electrodes in two communicating solutions of the same salt of different concentrations and observing the course followed by the p.d. between the electrodes [Annal. Phys. Chem. 7. p. 536, 1879]. The experimental results now described show that, owing to the disturbing effects of the initial polarisation of the metallic plates, this method is unreliable. Further, not only the method of correction devised by Seitz [Abstract 820 (1898)], but also other means of correcting the results given by Weber's method, are inapplicable. The abandonment of the method is, therefore, recommended. T. H. P.

2167. *Remarks on the Theory of Solutions.* **A. F. Core.** (Phil. Mag. 47. pp. 977–991, May, 1924.)—In the absence of the necessary complete knowledge and analytical skill required for the deduction of the complete behaviour of a solution by a thorough application of statistical mechanical principles, treatment is sometimes attempted by the " gas method," in which the solute molecules are essentially considered as a gas. The validity of this method having been attacked by Cavanagh in his paper " Molecular Thermodynamics " [Abstract 1659 (1922)], it is sought in the present paper to justify the " gas method " under certain conditions. In Cavanagh's paper, the suggestion is made that, by measuring the colligative properties of the solutions of certain solutes in associating solvents, the degree of association of the solvent may be determined, and an attempt is made in the present paper to show that this is not possible. Emphasis is laid on considerations illustrating the disadvantages of using the relationship of the total energy and volume of a mixture with the composition as a starting point for the thermodynamical treatment.
A. B. C. L.

2168. *Superficial Solutions and the Gas Law.* **A. Marcelin.** (Comptes Rendus, 178. pp. 1079–1081, March 24, 1924.)—The film of oleic acid, of greater extent than that corresponding with molecular juxtaposition [Abstract 1022 (1923), 186 (1924)], forms on the surface of the water a true two dimensional gas or, more exactly, a superficial solution, which may be reversibly compressed or dilated and which has at any instant a measurable pressure. Contrary to the author's original view, with surface lying between twice and nine times the saturation surface, this two dimensional gas obeys the law for perfect gases, the product of the surface and the surface pressure being constant. When the surface is extended still further, this product gradually diminishes, possibly owing to the influence of capillary actions and to the increasing difficulty of maintaining the surface of the water free from fatty impurities derived from atmospheric dust.
T. H. P.

2169. *The Inter-Ionic Attraction Theory of Ionised Solutes. Part I. Critical Presentation of the Theory.* **A. A. Noyes.** (Am. Chem. Soc., J. 46. pp. 1080–1097, May, 1924.)—The inter-ionic attraction theory, as developed by Milner [Abstract 1071 (1912)], and Debye and Hückel [see Abstract 2328 (1923)], in order to account for the deviations of largely ionised substances from the laws of perfect solutions is discussed by the author. This theory is based on the assumption that owing to the attraction between positive and negative ions, work is done on diluting a solution against this electrical attraction, with a corresponding increase in the energy content of the solution. The two independent investigations quoted above arrived at practically the same conclusion, the difference ΔU in the energy possessed by one mole of an ion of valence ν at absolute temperature T, when present in two different solutions of dielectric constant K, one infinitely dilute (with no inter-ionic attraction) and the other containing this ion and other ions of valence ν and molal concentrations c which are expressed by $\Sigma(c\nu^2)$, is given by $\Delta U = \dfrac{A\nu^3\sqrt{\Sigma(c\nu^2)}}{K^{1\cdot5}T^{0\cdot5}}$. A is the product of certain universal constants, and in c.g.s. units is $7\cdot77 \times 10^{15}$. Mathematical and thermodynamical discussions are given for the relation between energy and free energy effects ; calculation of free energy effects from vapour pressure and osmotic pressure, and expressions for the activation of the ions. The free energy decrease attending transference of one mole of an ion of valence ν from a concentration c (corresponding to $\Sigma(c\nu^2)$) to concentration c_0 (infinite dilution) is given by

$$-\Delta F = RT \log_e \frac{c}{c_0} - \frac{A\nu^2\sqrt{\Sigma(c\nu^2)}}{K^{1\cdot5}T^{0\cdot5}}$$

The agreement between the expressions derived by various independent methods is sufficiently close to provide strong evidence that these expressions are a true representation of the inter-ionic attraction theory. Moreover, if this theory succeeds in explaining the deviation of largely ionized substances from perfect solutes, it will support the view upheld by many recent investigators that these solutes are completely ionised up to moderate concentrations [see Abstract 158 (1924)]. The mathematical reasoning in this paper cannot be abstracted. B. W. C.

2170. *The Inter-Ionic Attraction Theory of Ionised Solutes. Part II. Testing the Theory with Experimental Data.* **A. A. Noyes.** (Am. Chem. Soc., J. 46. pp. 1098–1116, May, 1924.)—The activation function for a substance with two ions A and B, deduced from the expressions given in the previous paper [see preceding abstract], is given by

$$\frac{\log_{10}(a_A)^{1/\nu^A}(a_B)^{1/\nu^B}}{\nu^A+\nu^B} = 0\cdot357\sqrt{\Sigma(c\nu^2)} \text{ at } 25^\circ \text{ C.}$$

This requires that if the activity product is plotted as a logarithm against the values of $\frac{1}{2}\sqrt{\Sigma(c\nu^2)}$, *i.e.* ionic strength, the resulting graphs should be straight lines for all salts; they should coincide for different substances of the same valence types; and for substances of different valence types; the slope should correspond to the numerical factor 0·357 quoted above, or another factor two-thirds of this arrived at by another method.

The results with the activation product computed by Lewis and Randall from freezing point and electromotive force data, are in satisfactory agreement with the requirements of the theory, up to strengths of 0·05 M; especially if the nature of the constants and calculations involved is considered. The values calculated by the author for the activity product from the solubility effects of various salts afford a more extensive testing, especially with uni-univalent salts such as silver bromate and thallous chloride, whose graphs are nearly straight lines, almost entirely within the narrow sheaf bounded by the slopes corresponding to the numerical constants quoted above. The results with the uni-bivalent salts silver sulphate and barium bromate, and of the bi-bivalent salt calcium sulphate, also confirm in general the theoretical predictions, although some deviations are recorded. The observations hold equally well whether or not the added salt has an ion in common with the solute, while according to the older theory of incomplete ionisation, these two cases are completely different. It is concluded, therefore, that so far as present evidence goes the inter-ionic attraction theory offers quite a satisfactory explanation of the behaviour of largely ionised substances. The mass of experimental data in this paper does not lend itself to abstracting. B. W. C.

2171. *Theory of the Effect of Strong Electrolytes on the Solubility of Salts.* **O. Schärer.** (Phys. Zeit. 25. pp. 145–159, April 1, 1924.)—It is concluded that the classical theory of the dissociation of strong electrolytes does not give a satisfactory explanation of the known facts, as a result of a critical survey of experimental data. The author assumes that the solubility effect depends upon electrical forces between the ions, the electrolytes being completely dissociated. If a certain average diameter a is assigned to the ions, expressions are derived which give very good quantitative agreement with the experimental figures of various investigators. The value of a which is calculated for each salt is of the order of magnitude to be expected. The theory developed by the author is compared with the hypothesis put forward by G. N. Lewis, of the independent activity of the ions, and the points of agreement noted. The nature and extent of the deviations of the experimental results from the requirements of the theories at stronger concentrations are discussed. B. W. C.

2172. *The Mechanism of Mutual Precipitation of Colloids.* **R. Wintgen** and **H. Löwenthal.** (Zeits. phys. Chem. 109. 5–6. pp. 391–396, 1924.) —It has been shown in previous work (Zeits. phys. Chem. 107. p. 403, 1923) that for colloids bearing an electrical charge the concentration may be expressed as an equivalent aggregation, *i.e.* ratio between weight and electrical charge. This principle is applied to the mutual precipitations of colloids, and from experiments with chromium oxide and gelatine sols, and stannic acid + alkali and chromium oxide sols, it is concluded that the conception of an "equivalent aggregation" provides a satisfactory explanation of the observed facts. Therefore the idea of normality and equivalent concentrations may be extended to colloidal solutions as well as to solutions of crystalloids. It is shown that colloidal solutions of dyestuffs have very small equivalent aggregations. B. W. C.

2173. *The Viscosity and Elasticity of Colloidal Solutions.* **H. Freundlich** and **Emmy Schalek.** (Zeits. phys. Chem. 108. pp. 153–174, Feb., 1924.)—The applicability of Poiseuille's law in the determination of viscosity is investigated in the case of a large number of sols by the method of Hess and that of Couette. In the former method a measurement is made, as in the Ostwald viscosimeter, of the rate of flow of a liquid through a standard capillary tube, a definite difference of pressure being maintained between the two ends. In the latter method, a cylinder is suspended by a torsion wire in the liquid, which is placed in an outer cylindrical container, and a measurement made of the turning moment imparted when the containing vessel is rotated at a definite speed.

A number of sols of the hydrophile class, such as sols of As_2S_3, La_2O_3, ZrO_2, CaF_2, and S, follow the Poiseuille law and behave like true solutions. Many sols exhibit a marked departure from the law. The deviations are all in the direction that, at low-velocity gradients or shearing velocities, the viscosity coefficients, calculated in the usual way, increase rapidly with falling velocity. With some sols, notably that of Fe_2O_3, this behaviour is more pronounced with the aged sol. In accordance with a theory put forward by Hatschek, this relation is explained by the fact that these sols are not only viscous, but also elastic, and the elasticity is relatively more marked with low-velocity gradients when the apparent viscosity is increased. In agreement with this theory, most sols which show this departure from Poiseuille's law exhibit elasticity when a measurement is made by the method of Freundlich and Seifriz [Abstract 1288 (1923)] of the magnetic displacement of metal particles in the sol. An agreement with the theory put forward is given by sodium stearate solutions, which are elastic when measured by the magnetic method, and depart markedly from the Poiseuille law, and by sodium oleate solutions, which are inelastic and conform to this law. J. N. P.

2174. *A Theory of the Elasticity of Colloidal Solutions.* **A. Szegvari.** (Zeits. phys. Chem. 108. pp. 175–184, Feb., 1924.)—As formerly demonstrated by Freundlich and Seifriz [Abstract 1288 (1923)], a modulus of elasticity and elastic limit can be ascribed to certain liquids. In the present work it is shown that, by assuming a constant fluid elasticity, the relation between resistance to flow and velocity gradient is given by the equation, $\omega = \delta/G + \eta$, where ω is the resistance to flow, δ the fluid elasticity, G the velocity gradient, and η the theoretical viscosity coefficient. This formula is followed particularly by dilute sols measured in the Couette apparatus. Elastic liquids are characterised by two constants which are independent of each other, the theoretical viscosity coefficients and the fluid elasticity. This independence is particularly noticeable with V_2O_5 sols, to which electrolytes are added in varying quantities. J. N. P.

2175. *Kinetics of the Process of Coagulation of Colloids in the Light of Smoluchowski's Theory.* **J. N. Mukherjee** and **S. K. Majumdar.** (Chem. Soc., J. 125. pp. 785–794, April, 1924.)—The authors have investigated, with reference to arsenious sulphide sols, the limits within which Smoluchowski's equations are valid [see Abstract 579 (1923)], and, assuming the validity of the equations, the variation in the percentage of effective collisions with the concentration of electrolyte. Comparison of the rates of coagulation of arsenious sulphide sol for different concentrations of electrolyte show that, in the region of slow coagulation the constant rate required by Smoluchowski's theory is observed only up to a certain stage of coalescence. In this region the greater the rate of coagulation, the more advanced is the limiting stage of coalescence. Near this limiting stage, and after it has been attained, Smoluchowski's equations fail completely. These results are explained on the assumption that coalescence is reversible or irreversible according to the potential of the double layer. It is reversible at sufficiently low concentrations of electrolyte, but it is irreversible when the potential of the double layer is small. The limiting stage results when there is an equilibrium between the rate of breaking-up of the aggregates due to fluctuations in thermal energy and that of coalescence. It is suggested that the hydration of the particles is influenced by the density of their electrical charge and that, in addition to the electrical potential, variations in the depth of the layer of hydration are responsible for the transformation of irreversible into reversible coalescence. T. H. P.

2176. *Influence of Anions on the Coagulation of Negatively Charged Suspensoids.* **J. N. Mukherjee** and **S. G. Chaudhuri.** (Chem. Soc., J. 125. pp. 794–802, April, 1924.)—The chlorides, bromides, nitrates, and sulphates of sodium and potassium, and the corresponding acids coagulate arsenious sulphide sols at a definite concentration of the respective kations, the influence of the anion being thus very small. Similar behaviour is shown by the coagulating concentrations of acids for gold sols. The effect of the valency or mobility of the ion, often observed when the ions concerned have a charge opposite in sign to that of the colloid, is almost absent when the ion has a charge of the same sign as the colloid. An anion having a complex chemical composition (for example, the benzoate, ferrocyanide,

or salicylate ion) exerts a marked influence and requires a higher kation concentration to produce coagulation. The coagulating effects of the alkali-metal kations are, in descending order of magnitude, Cs, Rb, K, Na, Li. The amounts of anions adsorbed for salts with univalent kations are very small in comparison with the total amount of electrolyte present.
T. H. P.

2177. *The Electronic Theory and the Heat of Formation of Salts.* **R. Audubert.** (Comptes Rendus, 178. pp. 1814–1816, May 26, 1924.)—When a metal is dissolved in a solution of another metal with precipitation of the latter the reaction $M_1 + M_2^{+}\overline{R} \rightarrow M_2 + M_1^{+}\overline{R}$ may be regarded as an electronic transformation. An electron dragged from M_1 with absorption of energy is attached to M_2 with liberation of energy. The difference being equal to the heat of the reaction. In seeking to express by a general formula the heats of formation (Q) of salts, the author has found that the following expression (similar to that of Balmer for the spectral rays of hydrogen) satisfies experimental data within 5 per cent., $-Q = A[b/m^2 - a/n^2]$. Here A is a general constant, a and b are two parameters, functions of the valency, m and n are whole numbers characteristic of the constituent elements. The term Ab/m^2 can be taken as referring to the cations, and Aa/n^2 to the anions. It thus appears that the heat of formation of a salt can always be represented by the difference of two numbers corresponding to the heats of ionisation of the anion and of the cation. It is interesting to observe that numbers are thus obtained for the halogen elements very nearly equal to those calculated by Born from very different considerations. **Errata** (*ibid.* p. 1932, June 2, 1924). T. B.

2178. *The Effect of the Deformability of Ions on the Optical and Chemical Constants.* **M. Born** and **W. Heisenberg.** (Zeits. f. Physik, 23. 6. pp. 388–410, 1924.)—The authors define the "deformability" of the ion as the ratio of the electrical moment produced to the strength of the electric field producing it, *i.e.* $p = \alpha F$ where p = electric moment, F = electric field strength, and α = deformability. A brief review is first given of the development of the quantum theory and of the results obtained by Kossel, Debye, Heydweiller, the recent work on the subject by Wasastjerna and by Fajans and Joos being specially mentioned. The authors employ a new method for the determination of α; this depends on the connection between α and the constants of series-spectra, *i.e.* the Rydberg and Ritz corrections. As an important secondary result of their work, the authors obtain a new proof for the "Halbzahlegkeit" of the azimuthal quantum number k required by the theory of the Zeeman effect. The body of the paper is divided into five sections, dealing with (1) dependence of Rydberg correction on the deformability of the atom-complex, only spectra being considered in which the atom-complex is of the type of the inert gases. (2) Deformability and refraction-constants of the inert gases and of salts. The result that the quantum number k is "halbzahlig" is here deduced from the deformability of the inert gases and of ions which are similar to them. (3) Dependence of the deformation on the charge of the nucleus. The authors here show that the law $\alpha = C \cdot Z_{\text{eff.}}^{-3}$ obtained by Kramers for the Bohr helium atom holds with considerable exactness in other cases also. (4) Heat of sublimation of salts. The values of α are used to calculate the heats of sublimation of the chloride, bromide, iodide and fluoride of the alkali metals. (5) Oscillations of binary-molecules. The authors have here been compelled to limit themselves to the three halogen acids, HCl, HBr, HF.

The paper is essentially mathematical, and contains tables of the calculated quantities, with a comparison of experimental values. The authors promise an extension of the investigation to more complicated molecules and ionic configurations. T. B.

2179. *Synthetic Metallic Bodies. Part III. Tenacity and Density of Synthetic Metallic Bodies and Adhesive Forces between Metallic Surfaces.* **F. Sauerwald and E. Jaenichen.** (Zeits. Elektrochem. 30. pp. 175–180, April, 1924.)—The tenacity, density and expansion of synthetic metallic masses prepared by the compression and sintering of fine-grained crystallites of copper and iron [see Abstract **2031** (1923)] have been investigated in relation to the previous heat treatment. The metals begin to exhibit tenacity at comparatively low temperatures, the maximum tenacity, which reaches the same order of magnitude as that of melted metal, occurring before spontaneous increase of the grain is detectable. Hence the development of tenacity and density in the material is attributed to the adhesive forces between the surfaces of the crystallites, these forces assuming considerable magnitudes at temperatures below those at which diffusion and crystallisation processes occur. The tenacity, and with copper the density also, is diminished by increase in the size of the grain, whilst, up to a certain limit, the expansion is simultaneously increased. Heating of iron at the lower temperatures of the γ-region results in minimum tenacity, density and expansion. T. H. P.

2180. *Inner Structure of Alloys.* **W. Rosenhain.** (Inst. of Metals, J. 30. 2. pp. 3–26, 1923. Engineering, 115. pp. 591–594, May 11, 1923.) —By comparing the results obtained from X-ray studies of alloys with other known properties it can be deduced that :—

(*a*) The atoms of the solute replace atoms of the solvent metal on the lattice, and do not fit into the interstices between them.

(*b*) The stranger atom in the lattice causes distortion, and the amount of distortion which the lattice can undergo is limited. The number of stranger atoms which can be introduced into the lattice will be determined by the stage at which the distortion reaches the limit of which the lattice is capable. Consequently, the kind of atoms which have a limited solubility will be those which produce the maximum distortion.

(*c*) Distortion also produces a hardening of the alloy, so that in systems of alloys those metals which have a low solid solubility produce the greatest hardening effect.

(*d*) The power of forming solid solutions is a function of the hardness of the added metal.

(*e*) With rise of temperature, the limiting parameter will be reached by the region in the neighbourhood of the solute atoms considerably before the limiting parameter is reached by the rest of the crystal. The consequence is that melting will commence at a lower temperature in those regions immediately surrounding the dissolved atom. The divergence between the liquidus and solidus is, therefore, simply a question of the range of distortion existing in the lattice.

(*f*) In a lattice in which the effect of the alloying element is not to produce expansion, but contraction, the melting-point should rise instead of falling.

(*g*) When the lattice is elastically distorted under stress, the limiting parameter is reached at the stage of elastic breakdown, and a new phase —an under-cooled liquid—is formed.

(*h*) Problems connected with diffusion and with electrical conductivity are also fully discussed in the paper. J. L. H.

2181. *Effect of Temperature on the Hardness of Copper Alloys.* **L. Guillet.** (Rev. de Mét. 21. pp. 295–302, May, 1924.)—The hardness of various copper alloys was measured at temperatures between 20° C. and 950° C. by means of a Brinell ball. The alloys studied were of copper, with zinc, zinc and nickel, tin, aluminium and aluminium silicon, aluminium iron and aluminium nickel. The original paper must be consulted for detailed results, the chief general deduction being that single-phase alloys remain harder at high temperatures than two-phase alloys. J. L. H.

2182. *The Potentiometric Determination of the Diffusion Rate of Metals in Mercury.* **E. Cohen** and **H. R. Bruins.** (Zeits. phys. Chem. 109. 5–6. pp. 397–421, 1924.)—The arrangement of the apparatus necessary to measure the diffusion rate of cadmium in mercury at various temperatures is described. The cadmium is deposited electrolytically from a cadmium sulphate solution on the surface of a mercury column acting as kathode, forming a very dilute amalgam. The p.d. between the mercury surface and a standard electrode is then measured potentiometrically at definite intervals; the diffusion coefficient is calculated from the formula $\sqrt{D} = \frac{2Jh}{cq\sqrt{\pi}}(\sqrt{t} - \sqrt{t - \theta})$, where D = diffusion coefficient in c.c. per sec., J = current strength in milliamperes, h = electro-chemical equivalent of cadmium, c = concentration of cadmium in mgs. per c.c. amalgam, q = area of mercury surface in sq. cms., t = time from commencement of experiment, and θ = time in which electrolysis takes place.

This introduces corrections for the influence of current strength on the result. The procedure to be followed in making a measurement is described, and the effect of the shape and position of the cadmium anode and the strength of the $CdSO_4$ solution on the results is considered. The value of the coefficient at 20° C. and 1 atmosphere pressure is $1 \cdot 520 \times 10^{-5}$ cms. per sec. The results and methods of previous investigators are critically examined in the light of the authors' work. B. W. C.

2183. *The Influence of Pressure on the Rate of Diffusion of Metals in Mercury.* **E. Cohen** and **H. R. Bruins.** (Zeits. phys. Chem. 109. 5–6. pp. 422–430, 1924.)—The apparatus already described [see preceding Abstract] is adapted for use at high pressures, and the diffusion rate for cadmium in mercury measured in the same way at 1 atmosphere and 1500 atmospheres pressure. The effect of the increased pressure on the area of the mercury surface and the compressibility of the amalgam must be taken into account. The coefficient at 1500 atmospheres was found to be $1 \cdot 446 \times 10^{-5}$ cms. per sec. at 20° C., a decrease of over 5 per cent. of the value at 1 atmosphere. B. W. C.

2184. *The Propagation of the Wave of Shock.* **P. Laffitte.** (Comptes Rendus, 178. pp. 1277–1279, April 7, 1924.)—An investigation is made of the explosion of a number of different types of explosives by a recording photographic method. The explosive is placed so as to occupy only a portion of a glass tube of 5–15 mm. diameter, and detonation is initiated by means of fulminate of mercury, which is fired electrically. The photographic cylinder is caused to rotate with a velocity of 40 to 45 m. per second. Two separate effects can be recognised in the photographic tracing: first a straight line corresponding to the propagation of the explosive wave, and giving, by its inclination, a measure of the velocity; and subsequently, a second image with an initial luminosity equal to that of the explosive wave, but rapidly decreasing. The second image corresponds to a wave of shock which is formed in contact with the surface of the explosive, and is conveyed beyond in the air or other gas contained in the tube. The varying inclination of the second image shows that the speed of propagation of the wave shock initially is generally higher than that of the explosive wave, and then slows down. In any particular gas, the wave ceases to be luminous after a certain distance, which, for a given explosive, depends on the density of loading and on the diameter of the tube. A description is given of the characteristic properties shown when the wave of shock is conveyed in different gases. [See Abstract 156 (1924).] J. N. P.

2185. *The Mechanism of the Explosive Reaction.* **Audibert.** (Comptes Rendus, 178. pp. 1275–1277, April 7, 1924.)—A straight tube of uniform internal diameter (12 mm.) is composed of three sections, the two outer ones being of glass and the central one of thin rubber. The detonation is initiated at one of the open extremities of one of the glass sections, and the flame is photographed on a rotating drum. The image obtained consists of two equally inclined straight traces separated by a dark interval corresponding to the section of rubber. The two parallel traces are either in the same straight line or else displaced according to whether any modification of the progress of the explosion wave is introduced through the walls of the rubber tube. With the mixture $CH_4 + 2O_2$, a displacement is observed, but with hydrogen and oxygen this only occurs when nitrogen is also present. The result indicates that the oxidation of hydrogen at high temperatures and pressures is retarded by the presence of nitrogen in analogy with a similar result previously observed with carbon monoxide [Abstract 2013 (1923)]. The effect is attributed to the momentary formation of N_2O, and it is considered that a similar reaction proceeds during the detonation of nitroglycerine. The mechanism of the explosive reaction is considered to proceed as follows: The atoms composing the molecules enable the progress of a number of alternative reactions. Under the conditions of temperature and pressure prevailing in the wave, one of these reactions is more rapid than the others, and, by its progress, determines the velocity of the explosion wave. The gaseous residue then interacts by secondary exothermic reactions. The duration of the explosion is accordingly inversely proportional to the speed of the secondary reactions. The reaction interval is particularly short, attended by the highest shattering effect of the explosion, in cases where secondary reactions are absent or where the most rapid reaction is at the same time the most strongly exothermic. This condition is obtained with compounds of a simple constitution, such as certain chlorides, sulphides and azides.

It is concluded that the decomposition of a disruptive explosive gives rise to reactions between gases which involve the oxidation of reducing bodies, as hydrogen and carbon monoxide, with the production of flame. If the explosion takes place in an inflammable atmosphere, as in fire-damp, safety from ignition is dependent on the condition that the flame-producing reactions are either arrested or brought to completion before making contact with the surrounding medium. The tendency to ignite is greater in some explosives than in others, but in this connection no absolute distinction can be drawn between safe and unsafe explosives. J. N. P.

2186. *The Electrolytic Potential of Calcium.* **M. Tamele.** (J. Phys. Chem. 28. pp. 502–505, May, 1924.)—The electrolytic potential of calcium is determined experimentally by measuring the p.d. between a calomel electrode and a dilute calcium amalgam in water and the p.d. between the same amalgam and a calcium electrode in pyridine. The result gives − 2·758 ± 0·004 volts, with the normal hydrogen electrode as zero. The potential is also calculated from Nernst's theorem, using the specific heats of calcium, calcium oxide and hydroxide, and the heat of oxidation of calcium. This method gives − 2·77 volts. The relation of these results to recent work of J. Heyrovský [see Abstract 1279 (1923)] is discussed. B. W. C.

2187. *Significance of the Electrode Potential. Reply to the Criticism of J. A. V. Butler.* **J. Heyrovský.** (Chem. News, 128. pp. 357–359, June 6, 1924.)—A reply is given to a criticism of J. A. V. Butler [Abstract 1035 (1924)], on an earlier paper by the author [Abstract 1268 (1923)]. It is explained that, contrary to Butler's statements, no stages of the cyclic process devised by the author are irreversible, and that everywhere only free energy terms are used. It is reaffirmed that the ionisation potential I, may be taken as a measure of the free energy and, except at absolute zero, is not equivalent to the total energy. With increasing temperature more atoms have their valency electrons in the outer levels, and the ionisation potential becomes progressively less, although the total energy of ionisation remains the same, being determined by the convergent frequency $h\nu_\infty$.

It is concluded that Butler's second objection that the sum of the electric potentials round the cycle is zero is based on a thermodynamic error. An inference which follows from Butler's deduction is that the pressure of metallic ions over the dry, isolated metal is in equilibrium with the concentration of unhydrated metallic ions imagined to exist in the vapour of the solution which contains the hydroxide MeOH. It is maintained, however, by the author that at the electrode the metallic vapour is not in chemical equilibrium with the solution but might be acted upon by water and yet have its characteristic or electrolytic potential. By modifying the formula derived by Butler in accordance with these corrections, the same relation is derived between the electrode potential and the basic and ionisation constants as has been deduced by the present author, thus furnishing a further proof of the correctness of the deductions made by the latter. **Errata** (*ibid.* 129. p. 36, July 18, 1924). J. N. P.

2188. *The Mechanism of the Development of a Potential Difference at the Boundary of Two Phases.* **D. Reichinstein.** (Zeits. Elektrochem. 30. pp. 238–246, May, 1924.)—If it be assumed that for two given phases all ions, and also electrons, have the same partition coefficient, three propositions may be formulated which offer a simple explanation for the development of a p.d. at the bounding surface of two phases.

(1) The existence of asymmetrical conditions in the homogeneous phase is necessary in order to produce a potential difference. If, for example, a metal is placed in contact with an ideal pure solvent, no p.d.

will result; but if a salt is dissolved in the solvent, asymmetry results, and heterogeneous equilibrium between the phases cannot be attained, therefore a potential difference is set up. The value of this is expressed in terms of the concentration in the liquid phase. The case of an oxidation-reduction electrode—*e.g.* with ferrous and ferric sulphate in the solution—is considered.

(2) If a solid body is capable of causing chemical equilibrium between ions and electrons to be set up in a finite time in its own "reaction space," then by contact with a solution in which unsymmetrical equilibrium exists, only asymmetrical equilibrium can result in the "reaction space." The bearing of this on the reversibility of processes in animal and vegetable tissues is discussed.

(3) At the boundary of two phases a potential difference will develop if various degrees of asymmetry exist in the phases with regard to the same electrolytic or electronic dissociation process. This is illustrated by the chain sodium oleate in water/oil/sodium chloride in water, which is reversible with regard to sodium ions. Electrolysis considered as an example of asymmetry in the homogeneous phase is discussed, and the relations between the author's theory and classical thermodynamical reasoning are illustrated.

The theories are compared in their treatment of electrolysis effects and the Richardson effect in the discharge of electricity through rarefied gases. The theory of Smits and Aten (Ph. Ch. 92. 11, 1918) with regard to the development of p.d. is examined critically, and it is concluded that the author's theory gives a simpler and more satisfactory explanation of the facts. B. W. C.

2189. *The Oxidation Potentials of the Molybdenum and Tungsten Octocyanides.* **O. Collenberg.** (Zeits. phys. Chem. 109. 5–6. pp. 353–374, 1924.)—The reactions between potassium cyanide and compounds of molybdenum and tungsten yield tetravalent complex cyanides of the type $K_4R(CN)_8$. Oxidised with permanganate in sulphuric acid, the compounds pass into pentavalent complexes $K_3R(CN)_8$. In aqueous solutions the complexes dissociate into $K^•$ and a negative tetravalent or trivalent ion. The author determines the oxidation potentials by measuring the e.m.f. of cells containing electrodes of mercury in calomel and potassium chloride and of platinum in the cyanide, and also in concentration cells. The oxidation potential of the tungsten octocyanide is 0·569 at 0° with a cyanide concentration of 0·0964 mol, that of the molybdenum compound 0·829 volt; addition of KCl makes the potential more positive. The phenomena resemble those of the iron cyanides studied by E. Müller (*ibid.* 88. p. 46, 1914). H. B.

2190. *The Behaviour of Silver Iodide in the Photo-Voltaic Cell.* **A. Garrison.** (J. Phys. Chem. 28. pp. 333–345, April, 1924.)—Becquerel first observed that the photo-potential of the silver iodide electrode electrolyte cell was not always positive. Minchin observed similar effects with several cells, but regarded the negative effect as exceptional. In the case of the cuprous oxide photo-voltaic cell it was formerly thought that the photo-potential was always positive but it has recently been shown that the potential induced by the light may be either + or — depending on the condition of the electrode and the nature of the electrolyte. In the present paper experiments are described which show a remarkable similarity between the action of the silver halides and cuprous oxide. The same general theory applied to both, the conditions which determine both the nature and the direction of the light effects being almost identical. The results are of interest in photography, because they furnish new data on the photo-chemical behaviour of the silver halides.

The light-sensitive electrodes were prepared either by the direct action of the vapours of the halide or by electrochemical deposition of a thin layer of the silver halide on a polished silver electrode. The electrodes were made of thin sheet silver about 3 cm. in length and 2 cm. in width. They were always coated on the back with paraffin so that only the front surface which was exposed to the light was in electrical contact with the electrolyte. The electrolyte was always saturated with silver iodide. The electrode and electrolyte were placed in a rectangular glass vessel painted with black paint on all sides but one in such a way that the light had to traverse only 0·5 cm. of the electrolyte before falling on the electrode. A 0·10 N. calomel half-cell completed the photo-voltaic cell. The cell was mounted in a light-proof box with a single window for admitting light to the sensitive electrode. A 500 c.p. tungsten filament lamp was used as a light source. As a result of the experiments it is proved that silver iodide photo-voltaic cells have been made which have both positive and negative photo-potentials. The sign of the photo-potential was found to depend on the thickness of the silver iodide layer over the electrode, and on the ratio of the concentration of silver ions to that of iodine ions in the electrolyte. The relation between the light intensity and the changes in electrode potential were measured for both the positive and the negative effects. Decomposition of the silver halide was found to occur during the maximum negative effects in the presence of a high concentration of silver ions. The results are in agreement with the theory that the silver iodide becomes more soluble in light. The relation between light intensity and photo-potential has been obtained by means of this theory. J. J. S.

2191. *The Electromotive Behaviour of Magnesium.* **A. Smits.** (Zeits. Elektrochem. 30. pp. 223–230, May, 1924.)—Aluminium and magnesium exhibit a less negative potential than would be expected in aqueous solutions of their salts, which cannot be explained by the assumption of an oxide film on the metal surface [see Abstract 186 (1921)]. The behaviour of magnesium, for example, shows that it cannot be regarded either as a true gas electrode or a true metal electrode. The author assumes that some form of internal equilibrium is set up in the metal; the evolved hydrogen cannot be involved in this equilibrium, since this would lead to an impossible value for the concentration of hydrogen ions in the liquid. Probably the hydrogen forms an adsorption complex with the surface layer of the magnesium. The accelerating or retarding influence of ions such as OH, Cl, SO_4, on the attainment of the internal equilibrium, is illustrated and discussed. The magnesium is activated by amalgamation with mercury, and the influence of this addition on the internal equilibrium is considered. The magnesium electrode becomes very strongly negative if mercuric chloride is added to it in an acid solution. On being removed and washed, the potential is − 1·970 volt in normal KOH and − 1·850 volt in $MgSO_4$ solution. B. W. C.

2192. *The Hydrogen Over-voltage of Zinc.* **G. M. Westrip.** (Chem. Soc., J. 125. pp. 1112–1121, May, 1924.)—The over-voltage at a zinc kathode is measured by the direct method under various conditions of surface, current density and temperature, also in the presence of zinc sulphate and of gelatin. The liberation of hydrogen is assumed to be due to the decomposition of an adsorption complex first formed, and the equation $\eta = a + b \log D_K$ is deduced for the over-voltage, where η = over-voltage, a and b are constants, and D_K = current density. This expression is found to agree with the experimental results. An expression is also derived for the falling off of over-voltage with time after the circuit is broken, and the bearing of this on the commutator method of measuring over-voltage is pointed out. B. W. C.

2193. *Union of Electrolytically Prepared Sheet Metal.* **G. Eger.** (Zeits. f. Metallkunde, 16. pp. 134–135, April, 1924.)—The nature of the ground metal foil is easily recognisable from the appearance of the etched section of the kathode and deposit. The removal of an electrolytic deposit from the ground metal is, indeed, facilitated if the latter has a rolled structure, since, with a deposit on electrolytically prepared sheet, the crystals grow further in the direction of the current, although the separating layer produced by interruption of the current remains visible.

Deposits of *iron-nickel alloys* on polished brass plates may be obtained by alternate deposition of layers of nickel and iron, these being caused to alloy by being heated to a temperature short of the melting-point. T. H. P.

2194. *The Electrolytic Reduction of Tungstic Acid in Hydrochloric Acid Solution.* **O. Collenberg** and **J. Backer.** (Zeits. Elektrochem. 30. pp. 230–238, May, 1924.)—Solutions of alkali tungstates in concentrated hydrochloric acid, which contains tungsten mainly as WO_2Cl_2, and partly in the form of the complex anion WO_2Cl_3', are reduced by a Pt. kathode quantitatively to the deep-blue-coloured pentavalent tungsten stage. With mercury, lead, or tin kathodes the reduction of sodium tungstate in concentrated hydrochloric acid at all current densities proceeds quantitatively to the trivalent tungsten stage provided the temperature is not below 16° C. The corresponding potassium tungstate solutions are reduced by lead kathodes at a c.d. of 0·064 amp./cm.^{2} and at temperatures above 16° C., quantitatively to trivalent tungsten. With mercury kathodes the reduction is incomplete at all temperatures, and leads to an indefinite product, the valency of which is lower the higher the temperature and the higher the current density. At temperatures much below 15° C. the reduction of sodium tungstate in hydrochloric acid solution does not proceed completely to the trivalent stage on account of the stability of the quadrivalent tungsten chloride at low temperatures. Trivalent tungsten solutions obtained by electrolytic reduction are either greenish-yellow or red, the former containing the complex anion W_2Cl_9''', and being obtained in the pure condition when the temperature is above 35° C., while the red solution is best obtained by the use of lead kathodes, a c.d. of 0·064 amp./cm.^{2}, and a temperature of 16–18° C., and probably contains the anion $WCl_5 . H_2O''$ or WCl_5''. This latter form is comparatively unstable, and is gradually transformed to the green-yellow solution. The trivalent tungsten solution is strongly reducing, and in contact with Pt. or finely divided quartz sand is decomposed with evolution of hydrogen. In more dilute hydrochloric acid solution the reduction proceeds quantitatively to the trivalent stage, the solution in this case being less stable and is rapidly oxidised by air to the tetravalent form. J. N. P.

2195. *Effect of an Electric Current on the Motion of Mercury Globules in Dilute Sulphuric Acid, and its Bearing on the Problem of the Electrolytic Double Layer.* **J. E. P. Wagstaff.** (Phil. Mag. 47. pp. 802–815, May, 1924.)—An experimental investigation is made of the phenomenon, observed by R. Whiddington, presented by small globules of mercury which, when injected into a tube of dilute H_2SO_4, inclined at a small angle to the horizontal, can be made to move up the tube against gravity by sending a current in a particular direction through the acid. The velocity of the globule is found to be constant during its progress, and is a linear function of the p.d. between the ends of the tube. For a given p.d. the velocity varies with the radius of the globule in accordance with the Stokes-Ladenburg law of viscosity. Experiments with non-electrolytes in the tube show that mechanical forces, such as arise when a conducting sphere is placed in an electrostatic field, can be neglected in any theoretical considerations of this phenomenon. A theoretical explanation of the results obtained is developed, introducing the definition of a critical diameter (for globules of atomic size) below which no electrolytic double layer exists. A. B. C. L.

2196. *The Cataphoresis of a Sphere.* **E. Hückel.** (Phys. Zeits. 25. pp. 204–210, May 1, 1924.)—A continuation of the paper by Debye and the author [Abstract 1631 (1924)] deducing the formulæ for the movement of the liquid, the general distribution of velocity and pressure, and the total force acting on the sphere. It is shown generally, without reference to special cases, that, contrary to Smoluchowski, the values for the velocity of migration of an ion, calculated by Stokes' law and from the formula for cataphoresis, are in agreement. H. B.

2197. *Fibrous Structure in Metallic Electrolytic Deposits.* **R. Glocker and E. Kaupp.** (Zeits. f. Physik, 24. 2. pp. 121–139, 1924.)—X-rays were sent through sheets of the deposits, which could not be made less than 0·1 mm. thick without destroying the structure; hence a powerful X-ray tube with homogeneous radiation was required. Medium wave lengths, with strong photographic action, can be produced by using for the anti-cathode a metal closely following silver in the periodic table, since the radiation from such a metal excites the silver radiation of the photographic granules, an alloy of 33 per cent. nickel and 67 per cent. antimony, which melts only at 1158° C., appears to be suitable; but the actual measurements were made with silver anticathodes. In several electrolytically deposited metals it was shown that the crystallites were regularly arranged, so as to form a "fibrous" structure; with copper the axis of the fibres is in the [011] direction, with iron [111] or [112], according to the electrolyte used, with nickel [001] and with chromium [112]; no fibrous structure was observed with platinum, while silver from silver nitrate gave a somewhat complicated result. As noted above in the case of iron, the crystallographic direction of the fibre axis depends on the composition of the electrolyte; it appears that the axis always has in the direction of maximum velocity of growth of the particular crystal in the solution concerned. The nature of the cathode employed influences the production of fibrous structure, which is produced most readily when the cathode and the deposit are the same metal. H. N. A.